Walter V. Bradley.

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DIVISION OF MINES
FERRY BUILDING, SAN FRANCISCO

WALTER W. BRADLEY State Mineralogist

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CALIFORNIA

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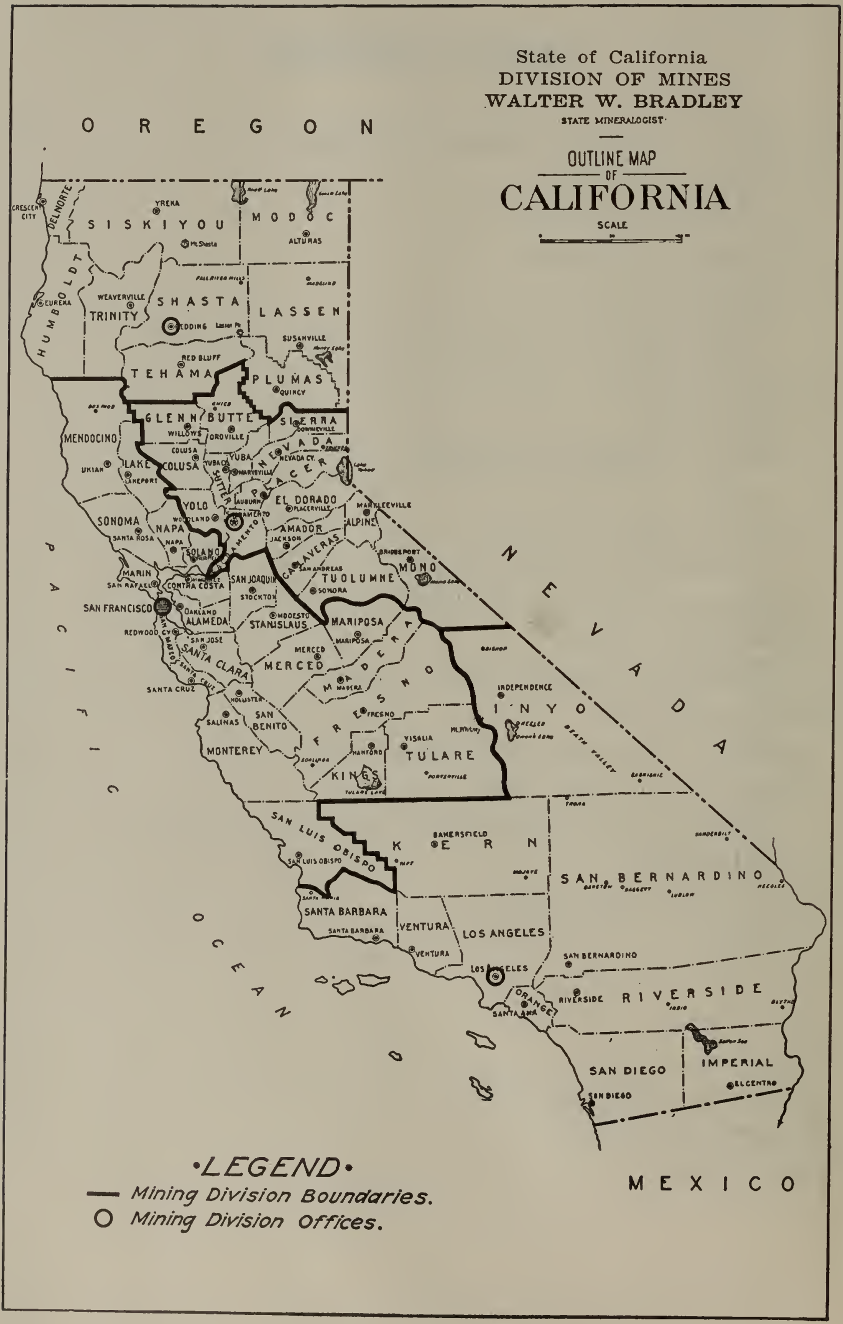


State of California
DIVISION OF MINES
WALTER W. BRADLEY
STATE MINERALOGIST

OUTLINE MAP
OF
CALIFORNIA

SCALE

•LEGEND•
— Mining Division Boundaries.
○ Mining Division Offices.

OREGON
NEVADA
PACIFIC OCEAN
MEXICO
DEL NORTE
CRESCENT CITY
SISKIYOU
YREKA
Mt. Shasta
MODOC
ALTURAS
HUMBOLDT
EUREKA
TRINITY
WEAVERVILLE
SHASTA
REDDING
LASSEN
SUSANVILLE
TEHAMA
RED BLUFF
PLUMAS
QUINCY
MENDOCINO
UKIAH
GLENN
WILLOWS
BUTTE
OROVILLE
CHICO
SIERRA
DOWNIEVILLE
NEVADA
NEVADA CY.
YUBA
MARYSVILLE
COLUSA
LAKE
LAKEPORT
SUTTER
YUBA CITY
PLACER
AUBURN
YOLO
WOODLAND
SACRAMENTO
EL DORADO
PLACERVILLE
ALPINE
MARKLEEVILLE
AMADOR
JACKSON
SONOMA
SANTA ROSA
NAPA
SOLANO
MARIN
SAN RAFAEL
CONTRA COSTA
SAN FRANCISCO
SAN JOAQUIN
STOCKTON
CALAVERAS
SAN ANDREAS
TUOLUMNE
SONORA
MONO
BRIDGEPORT
ALAMEDA
OAKLAND
REDWOOD CY.
SAN MATEO
STANISLAUS
MODESTO
MARIPOSA
SAN JOSE
SANTA CLARA
MERCED
MADERA
SANTA CRUZ
HOLLISTER
SAN BENITO
SALINAS
MONTEREY
FRESNO
INYO
INDEPENDENCE
DEATH VALLEY
TULARE
VISALIA
PORTERVILLE
HANFORD
KINGS
SAN LUIS OBISPO
KERN
BAKERSFIELD
MOJAVE
SAN BERNARDINO
NEEDLES
SANTA BARBARA
VENTURA
LOS ANGELES
RIVERSIDE
BLYTHE
ORANGE
SANTA ANA
SAN DIEGO
IMPERIAL
EL CENTRO

PREFACE

The Division of Mines (formerly State Mining Bureau) is maintained for the purpose of assisting in all possible ways in the development of California's mineral resources.

As one means of offering tangible service to the mining public, the State Mineralogist for many years has issued an annual or a biennial report reviewing in detail the mines and mineral deposits of the various counties.

As a progressive step in advancing the interests of the mineral industry, and as permitting earlier distribution to the public, publication of the Annual Report of the State Mineralogist in the form of monthly chapters was begun in January, 1922, and continued until March, 1923. Owing to a lack of funds for printing this was changed to a quarterly publication, beginning in September, 1923. For the same reason, beginning with the January, 1924, issue, it became necessary to charge a subscription price. This covers approximately the cost of printing.

Pages are numbered consecutively throughout the year and an index to the complete report is included annually in the closing number.

Beginning with the 1930 issues, the activities and progress of the Geologic Branch are recorded also in these quarterly chapters. The important part that geology plays in the economic development of our mineral resources is further recognized in the change of title from MINING IN CALIFORNIA to CALIFORNIA JOURNAL OF MINES AND GEOLOGY, beginning with the January, 1933, chapter.

Such a publication admits of several improvements over the former method of procedure. Reports of the current development and mining activities of the State, prepared by the district mining engineers are given. Special articles dealing with various phases of mining and allied subjects by members of the staff and other contributors are included. Mineral production reports formerly issued only as an annual statistical bulletin are also published herein as soon as returns from producers are compiled. The executive activities, and those of the laboratory, museum, library, employment service and other features with which the public has had too little acquaintance also are reported.

While current activities of all descriptions are covered in these chapters, the practice of issuing from time to time technical reports on special subjects will be continued as well. A list of such reports now available is appended hereto, and the names of new bulletins will be added in the future as they are completed.

The chapters are subject to revision, correction and improvement. Constructive suggestions from the mining public will be gladly received, and are invited.

The one aim of the Division of Mines is to increase its usefulness and to stimulate the intelligent development of the wonderful, latent resources of the State of California.

Types of Reports

In general the reports presented in these chapters are grouped into three classes:

1. Mines and mineral resources of a given County (describing kind, character, distribution and extent of development).

2. Specific economic and industrial mineral products (listing and describing the resources over the entire State of a given mineral substance, e.g. feldspar).

3. Geological reports on specific areas (recording results and conclusions, with maps, derived from field studies; and tied in with economic possibilities, and developments).

REPORTS OF DISTRICT MINING ENGINEERS

In 1919–1920 the Mining Bureau was organized into four main geographical divisions, with the field work delegated to a mining engineer in each district, working out from field offices that were established in Redding, Auburn, San Francisco and Los Angeles, respectively. This move brought the office into closer personal contact with operators, and it has many advantages over former methods of conducting field work, including lower traveling-expense bills for the Bureau's engineers. In 1923 the Redding and Auburn field offices were consolidated and moved to Sacramento.

The Redding office was reestablished in 1928, and the boundaries of each district adjusted. The counties now included in each of the four divisions and the locations of the branch offices are shown on the accompanying outline map of the State. (Frontispiece.)

Reports of mining activities and development in each division, prepared by the District Engineer, will continue to appear under the proper field division heading.

Although the petroleum industry is but little affiliated with other branches of mining, oil and gas are among the most valuable mineral products of California, and a report by the State Oil and Gas Supervisor on the current development and general conditions in the State's oil fields is included under this heading.

SACRAMENTO FIELD DIVISION

C. A. Logan, Mining Engineer

Mr. C. A. Logan, District Engineer, is engaged in the preparation of a special report upon the Mother Lode Gold Belt of California, which it is planned will be published soon.

SAN FRANCISCO FIELD DIVISION

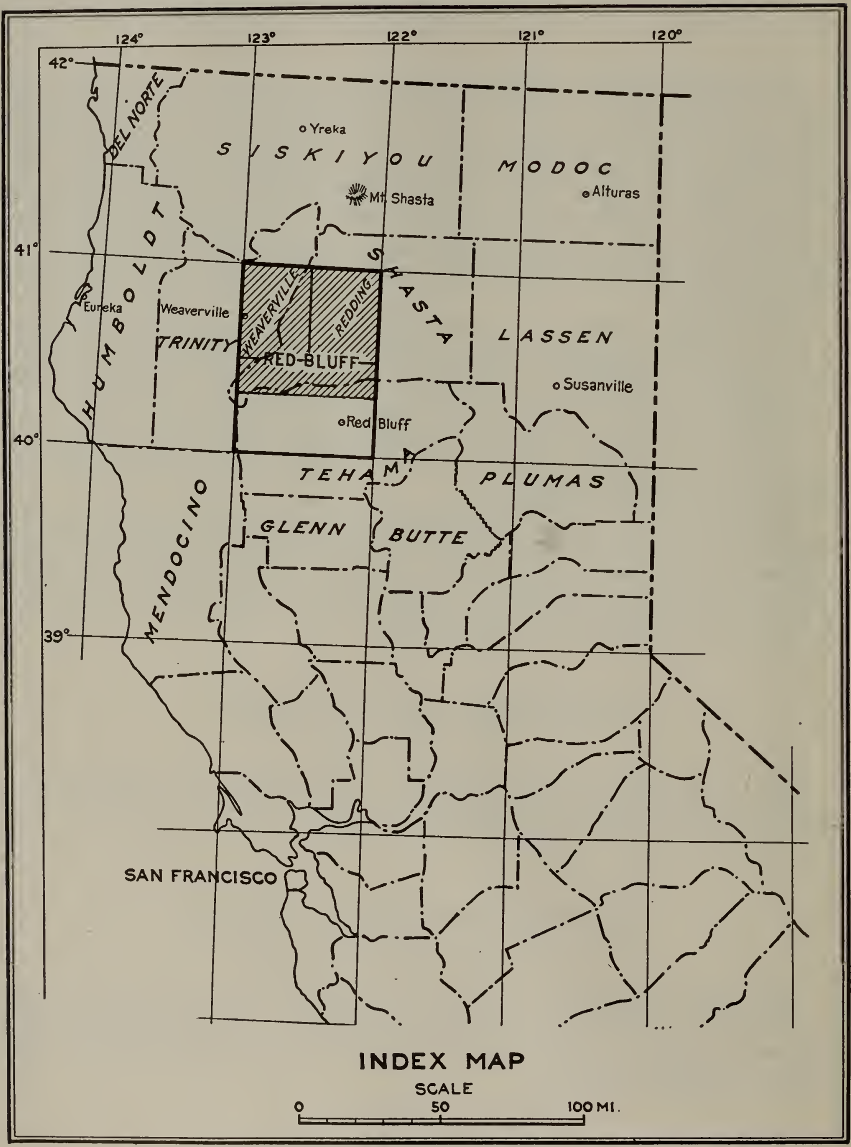
C. McK. Laizure, Mining Engineer

Reports covering the mines and mineral resources of all of the counties in the San Francisco field division are now available, and field work at present is confined to investigations for special reports upon various economic minerals.

LOS ANGELES FIELD DIVISION

W. B. Tucker and R. J. Sampson, Mining Engineers

Reports covering the mines and mineral resources of all of the counties in the Los Angelés field division are now available, and field work at present is confined to investigations for special reports upon various economic minerals.


124°
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40°
39°
DEL NORTE
SISKIYOU
MODOC
Yreka
Mt. Shasta
Alturas
HUMBOLDT
Eureka
Weaverville
TRINITY
WEAVERVILLE
REDDING
RED BLUFF
SHASTA
LASSEN
Susanville
Red Bluff
TEHAMA
PLUMAS
MENDOCINO
GLENN
BUTTE
SAN FRANCISCO
INDEX MAP
SCALE
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FIG. 1. Index map of northern California showing area covered in report.

REDDING FIELD DIVISION

CHAS. V. AVERILL, Mining Engineer

GOLD DEPOSITS OF THE REDDING AND WEAVERVILLE QUADRANGLES*

OUTLINE OF REPORT

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INTRODUCTION

Geography

The area covered by the present survey is that of the Redding and Weaverville quadrangles, good topographical maps of which have been published by the U. S. Geological Survey; also a small portion of the northern part of the Red Bluff quadrangle, of which only a reconnaissance topographical map is available. A degree of longitude, from 122° to 123° west, and half a degree of latitude, from 40° 30′ to 41° north, are included in the Redding and Weaverville quadrangles. They adjoin to the south the Shasta quadrangle, which was covered by a report similar to the present one in the January, 1931, chapter of State Mineralogist's Report XXVII.[1]

Redding, county seat of Shasta County, is located at the extreme northern end of the Sacramento River Valley, at the point where the river emerges from a canyon. Drainage from this central part of the area is in a general southerly direction. To the west is a divide separating Sacramento River drainage from Trinity River drainage, the latter flowing westerly to join the Klamath River near its outlet into the Pacific Ocean. Weaverville, county seat of Trinity County, is at the west edge of the area, on a tributary of Trinity River. Elevations vary from 500 ft. at Redding to nearly 9000 ft. above sea-level on the peaks in the northwest corner of the area. While lowlands suitable for farming are rather common in the southwestern part of the area, as a whole it is quite rugged and mountainous. Population is roughly 8000 or 10,000 persons.

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* This report is the economic supplement of the article following it by N. E. A. Hinds which is entitled "Geologic Formations of the Redding-Weaverville Districts, Northern California." The geologic map (in pocket) shows by a red overprint the locations of the gold mines described. The numbers used on the map correspond to those in the text.

[1] Averill, C. V., Preliminary Report on Economic Geology of the Shasta Quadrangle, State Mineralogist's Report XXVII, chapter for Jan., 1931.

Climate

Average annual rainfall at Redding is about 38 inches, which falls largely in the months of December, January and February, mostly as rain; although occasionally snow covers the ground for a few days at a time. At the higher elevations the amount of snow increases rapidly, and several feet are likely to lie on the ground during the winter months. The long summers are quite dry, with temperature at Redding reaching a maximum of 114° F. Weaverville is higher than Redding and has a slightly cooler climate with more snow in the winter.

Industries

Agriculture and mining are the chief basic industries, and there is some small-scale lumbering. Transportation is furnished by the main north-south line of the Southern Pacific railway, passing through Redding, and following the Sacramento River canyon. The Pacific Highway, the main north-south paved road, follows roughly the same route, but less of it is down in the canyon. A surfaced highway connects Redding and Weaverville, and a good road continues to the coast at Eureka. Another surfaced road runs easterly from Redding into the counties of Lassen and Modoc. In addition to these main roads, a large mileage of county and forest roads makes nearly all parts of the area accessible, with the exception of some of the steep mountains. Hydroelectric power is generated in large plants just to the east, and is available at reasonable rates. The resort-business, catering to vacationists, hunters and fishermen, is now attracting some attention.

The list of agricultural products is large, including fruits (but not much citrus fruit), melons, nuts, grains, hay, berries, olives, grapes, vegetables, cattle, sheep, hogs, honey and dairy products. Angora goats are raised for mohair.

Lumbering in this particular area has not reached large proportions, but big mills are operated just to the north, also at short distances to the east. Much of the area is National forest land, the part to the north being in Shasta National Forest, and the part to the west in Trinity National Forest.

Mining

The list of mineral products is also large, but for minerals other than gold the reader is referred to State Mineralogist's Report XXII.[2] The chapter for January, 1926, describes the mineral resources of Trinity County, and that for April, 1926, those of Shasta County. These publications are still available at offices of this division. They contain extensive alphabetical lists of the gold mines of the two counties, as well as descriptions of other mineral deposits. Owing to economic conditions, there is little activity at present in the development of minerals other than gold; hence the present report is confined to deposits of that metal.

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[2] Logan, C. A., Trinity Co., Jan., 1926; Shasta Co., April, 1926; Chapters of State Mineralogist's Report XXII.

Gold Mining

Development of gold mines and prospects has been very active recently, and evidently will continue so for some time. The quartz or lode mines and prospects are described in considerable detail in the present report, and probably not very many of them have been missed during the survey. In the case of the placer mines the situation is a little different. Hundreds of persons have been at work on the streams of the area, during the past year and longer, engaged in small-scale placer mining, with pans and small sluice-boxes, into which the gravel is shoveled by hand. One result of this is that practically all public land along the streams has been taken up by placer claim locations. The gravels of the area have already been so thoroughly worked by such methods, that the average return to the present-day small-scale placer miner is barely enough to buy his food. When the small amounts produced by each individual are added up to make the statistical totals, however, the aggregate production is found to be considerable.

Little would be gained by listing these small-scale operations, and time for it has not been available. Hence only the larger and more active placer mines have been listed and described; but it is felt that enough of these have been covered to give a good idea of placer mining in the area. Of course, much gravel remains in large, unworked deposits of low grade that do not contain enough gold to pay by small-scale hand methods. It is possible that thorough prospecting of some of these deposits will reveal local areas of good grade.

GOLD (Lode)

American Mine (No. 1), owned by William Franck and H. J. Franck of French Gulch, is in Sec. 12, 13, T. 33 N., R. 7 W., four miles from French Gulch. Redding is 25 miles southeast, 18 miles to Tower House being State highway, with a good dirt road from there to French Gulch. The four miles to the mine is fair dirt road, the last mile being on a steep grade, leaving creek level in Cline Gulch at an elevation of about 1500 ft., and reaching the lowest adit of the mine at an elevation of roughly 2500 ft. Claims held are the Mill Creek Quartz Mine, Rose Gold Quartz Mine, Golden Gate Mine, Inlet Gold Quartz Mine, Alpine Extension Mine and Alpine Mine. The property is leased by C. A. Westlake, E. C. Chenoweth, and N. C. Wheeler of French Gulch. Adjoining to the east is the Gladstone mine.

An upper level shows a 2-ft. quartz vein cutting through the Bragdon formation, siliceous conglomerate and black slate. The vein shows slickensiding and occupies a former fault that cuts through the sediments at a steeper dip than that of the bedding. The strike is east and west, and the dip nearly vertical. The ore is a white quartz stained brown at this upper level by oxides of iron. Some production has recently been made from these upper levels as mentioned below. Various old workings are to be found at different elevations from the lowest, or No. 5 adit level, clear to the outcrop, some 800 or 900 ft. higher in elevation.

The No. 5 adit level runs northerly for 1150 ft. to tap the vein, on which are old drifts 150 ft. to the east and 270 ft. to the west. Stoping has been done above this level for a length of 80 ft. New work consists of a 20-ft. winze below the No. 5 level at the point where it cuts the vein. This has opened up a 2 to 3-ft. stringer zone in black slate. The ore is largely white quartz showing specks of free gold, but there is quite an admixture of black slate in lenses and horses. Some of the ore shows a banded or ribbon-structure with alternating bands of black and white. Sorting consists of removing black slate from the ore. A shipment of sorted ore, half from this winze, and half from the upper workings, of 26 tons sent to the two-stamp mill of Ernest Blagrave at the Niagara, is stated to have produced $42 per ton in free gold only. At time of visit another shipment of sorted ore entirely from the winze was sacked and piled up at the mine. This was stated to be worth more than $50 per ton in free gold.

In the old workings, lessees state that the vein reaches widths considerably greater than those given above. To the west of the new winze, at a distance of 60 ft. is an old 110-ft. winze full of water. Lessees state that at the 100-ft. level a drift was run to the west for 70 ft., and to the east 15 ft. This work was done by a company some years ago. If this winze were pumped out, some 45 ft. of drifting to the east would be required to reach a point under the new winze.

The new winze makes a little water, which is syphoned out to a point below the portal of the No. 5 adit. A rubber-diaphram pump driven by a gasoline engine is used to keep this syphon in operation. At time of visit in June, 1932, lessees were erecting a 5-stamp battery of 1000-lb. stamps near the portal of No. 5 adit. Treatment will be amalgamation followed by table-concentration.

Bibl: State Mineralogist's Reports VIII, p. 564–65; X, p. 637; XII, p. 245; XIII, pp. 349, 357; XIV, p. 778; XIX, p. 135; XX, p. 15; XXII, pp. 169, 181. U. S. G. S. Bull. 540, pp. 35, 60–61.

Amy Balch Mine (No. 2) is a property of four unpatented mining claims in the Deadwood District, Sec. 13, T. 33 N., R. 8 W. Redding is 30 miles southeast by road, 18 miles of which is State highway; the balance is the old Tom Green stage road, climbing the mountain on fairly steep grades above French Gulch. Carter states that this mine has produced $35,000 or more from veins of ochre and quartz associated with the contact of the diorite porphyry and Bragdon slate. In some places the veins cut through both of the formations mentioned. This production was made in 1913 and earlier, with hand tools, and the treatment was in arrastras. Widths varied from a few inches to a maximum of 8 ft., with an average of about 2 ft. These workings have since caved. Only assessment work was done for many years, but recently Carter has been working steadily in a lower tunnel.

This lower adit is about 100 ft. lower than the lowest of the old workings, but 250 or 300 ft. above creek level. It starts in the slate then turns and follows a slate-porphyry contact. Some crosscutting has also been done in the porphyry, the total length of the working being about 150 ft. With the exception of a seam a few inches wide, no ore has yet been found on this level. In a tunnel about 50 ft. above the creek, a drift follows a vein of crushed country rock and quartz, which is said to assay a few dollars per ton in gold for a width of 2 ft. This is in the slate within a few feet of the porphyry contact.

In view of the location of this property adjoining the Brown Bear, which has been a heavy producer, and the Lappin, another producer, and the similarity of the occurrence of the ore in all three, the Amy Balch ground appears to be a favorable place for prospecting. M. G. Carter of Redding is owner.

Bibl: State Mineralogist's Reports XIII, p. 437; XIV, p. 884.

Arps Group (No. 3) is a group of 15 patented mining claims, 212 acres, in Sec. 20, 21, 28, T. 34 N., R. 3 W., owned by William Arps of Copper City (Ydalpom P. O.), D. V. Saeltzer of Redding and A. Jaegel. Arps states that 200 tons of ore were shipped from open cuts to smelters for gold and silver. Eroded surface material pans some free gold. Old development work consisting of six tunnels and shafts aggregating over 3000 ft. in length have mostly caved. Ore found in these deeper workings contains pyrite, sphalerite, chalcopyrite, some galena, with a barite gangue. The property has not been worked recently and there is no equipment. It adjoins the Copper City group of what is commonly known as the Bully Hill mines.

Bibl: State Mineralogist's Reports XIV, p. 761; XIX, pp. 89, 90; XX, p. 427; XXII, p. 145. Bull. 50, p. 110.

Atascadero Copper Co., see Greenhorn.

Baker Mine (No. 4), two unpatented claims in Sec. 22, T. 34 N., R. 6 W., is held by J. E. Daley and J. P. Collings of French Gulch. Redding is 31 miles southeast. Redding to Tower House, 18 miles, is State highway, then 7 miles county road to a point north of French Gulch, then 4 miles of mountain road and 2 miles of trail reach the mine, which is on the East Fork of Clear Creek at an elevation of 3000 ft.

There are two adit levels with a difference in elevation of only 15 ft. The total length of the upper is 120 ft. and of the lower, 135 ft. Daley and Collings have done about 100 ft. of drifting and 30 ft. of raising between levels, also some stoping from the raise. They state that about $5,000 has been recovered from irregular pockets. A small amount of the ore has been roasted in a wood fire to free the gold from the sulphides, and it has then been amalgamated. The free gold in the pockets is recovered by panning. A hand-mortar equipped with a screen, a small amalgamating plate and a spring pole for the pestle has been used to grind some of the ore.

The ore is found in irregular masses of quartz with pockets carrying free gold, near the contact of Copley meta-andesite and Bragdon slate. Dikes of dioritic and andesitic rocks are found in the vicinity, and probably some of this is associated with the ore; but this material is so highly silicified that its original composition is uncertain. Tunnels start in Copley meta-andesite, but the ore is found mostly in the black Bragdon slate. The veins are irregular in width, in strike, and in dip. The width varies from a fraction of an inch of gouge to six and eight feet of quartz, and changes in width are abrupt.

Balaklala Mine (No. 5), consisting of 72 patented claims and 800 acres of smelter and townsite land at Coram in Sec. 10, 11, 12, 13, 14, 17, 20, 21, T. 33 N., R. 6 W., is assessed to First National Copper Co., c/o S. A. Holman, 830 Mandana Boulevard, Oakland, California. Operations of this property as a copper mine have been described in State Mineralogist's Report XXII. The mine has not been operated for a number of years, and the roads have been washed out to such an extent that the last five miles must be traveled by trail.

Considerable interest has been shown recently in the gossan deposits at this property, and the installation of a cyanide plant similar to that of the Mountain Copper Co. at Iron Mountain has been considered. The Iron Mountain plant was described in detail in State Mineralogist's Report XXVII.[3] So far as is known at the present time the Balaklala deposit is not so large as that at Iron Mountain, but such sampling as has been done indicates the possibility of a better grade. Since 1914, no work has been done on the gossan with the exception of a little prospecting done on the deposit at the Angle Station by Vickery Brothers of Kennett in the summer of 1931. The following information on this gossan is derived from a letter from S. A. Holman, who has been connected with the company since 1914, and whose address is given above.

There are three gossan deposits of some size at the Balaklala property:

(1) Gossan lying on west side of creek and slightly south and west of the Glory Hole.
(2) Gossan lying on the east side of Mule Gulch just east of the main Weil ore body.
(3) Gossan lying north of the aerial cable-tramway angle station, and known as the ''Angle Station'' deposit.

During the early development of this property, from 1890 to 1900, shallow shafts and tunnels were put into the gossan on all three of the above deposits. Several hundred feet of shafts and tunnels were put in the Angle Station deposit, while only a little work was done on the other two deposits. In no case was sufficient work done to make possible a close estimate of tonnage, and openings made were not sufficient to afford enough samples to show the average value. Undoubtedly good values were found in parts of the Angle Station deposit, but further work will be necessary to determine tonnage and average values. Both the Glory Hole and Mule Gulch deposits lie either directly above, or close to, known sulphide deposits, but no sulphide has yet been found in the vicinity of the Angle Station deposit. There appears to be a good chance of proving a considerable tonnage of a commercial grade of gossan at the Angle Station, while both of the other deposits have sufficient showing to warrant further exploration.

Bibl: State Mineralogist's Reports XX, pp. 427–28; XXII, pp. 145–46.

Ballou Mine (No. 6) (Manzanita) is a group of five patented claims in Sec. 7, 18, T. 31 N., R. 6 W., six miles northwest of Igo, at an elevation of 2300 ft., owned by Mrs. May V. Ballou. More than 1000 ft. of tunnels were driven on this property years ago, and some production of gold was made. Recently R. S. Ballou of Igo has leased the five patented claims, and has made two additional locations on adjoining ground. Work done during the fall of 1932 consists of a 53-ft. drift adit and a 7-ft. winze on a vein not formerly worked. A shoot of pay ore from four inches to a foot wide has been found in a vein which reaches a maximum width of three feet of mineralized quartz and country rock. The ore is quartz rather heavily stained with oxides of iron, and carrying considerable sulphides, pyrite and chalcopyrite. Both walls are of quartz diorite. A shipment of 5½ tons of this ore (sorted) has recently been made to the Selby smelter. Rejects from the shipment, consisting of a few tons of mixed quartz and country rock on the dump, are stated to assay $25 per ton in gold; hence the shipment is expected to give returns considerably higher than this figure.

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[3] Averill, C. V., The Mountain Copper Co., Ltd., Cyanide Treatment of Gossan, State Mineralogist's Report XXVII, pp. 129–138, April, 1931.

At the time of visit, lumber was being hauled for the construction of a new mill. Water power is available from a Pelton wheel provided with a 10-inch pipe and a head of water of 65 ft. This power is to be used to pump from a new winze that Ballou expects to sink on the vein. Additional power can be developed by using a higher ditch. The wheel formerly drove a Straub mill, now in poor condition due to the burning of the building.

Bibl: State Mineralogist's Report XXII, p. 206.

Bateman and Mauldin Prospect (No. 7) is a property of four unpatented claims recently acquired by J. C. Bateman and G. L. Mauldin of Lewiston in Sec. 14, 15, T. 33 N., R. 8 W., 45 miles from Redding, via Lewiston, by state highway and county road. The Brown Bear mine is about a mile to the east.

A quartz vein on a contact of diorite porphyry and slate is exposed in an old tunnel 225 ft. higher in elevation than the present mill-site. This varies in width from a few inches to 4 and 5 ft. A 20-ft. winze has been sunk on the wider part. The best ore is stated to be in another old tunnel near the portal, which is 125 ft. higher in elevation than the mill-site. A black gouge is found here, with in places a few inches of quartz, also lenses and spots of crushed quartz in the gouge. Widths vary from a few inches to 18 inches. Here both walls are slate.

No recent development work or mining had been done at time of visit in May, 1932. Six men were at work installing a small mill consisting of small jaw crusher about 4 by 6 inches, Ellis cannon-ball mill and Ellis amalgamator. The outfit was to be driven by 1½ and 4-hp. gasoline engines.

Beaver Mine (No. 8) (Woodfill) is a property of four unpatented claims, 80 acres, located six miles west of Ono, or 23 miles west of Redding, in Sec. 7, T. 30 N., R. 7 W., held by Geo. E. Fenby and Frank C. Sherwood of Ono. A 76-ft. crosscut taps a north-south vein, on which there is a 76-ft. drift to the south and a 26-ft. drift to the north. Dip of the vein is 80° east. Near the point where the crosscut taps the vein, a 15-ft. winze has recently been sunk, and on the hanging-wall side a streak of good ore, one foot wide, is exposed. It is not solid quartz, but is a mixture of the green schistose country rock, quartz, calcite, pyrite, minor amounts of other sulphides and possibly tellurides, and some free gold. An 800-lb. shipment of sorted ore from this streak recently sent to the Selby smelter was settled for on the basis of a gross value of $69.97 per ton. Sample assays of from $40 to $300 are said to have been obtained. The balance of the bottom of the winze, a 7-ft. width of material largely country rock, is stated by the owners to assay $9.30 per ton. The vein has been stoped out from this tunnel level to the surface. A crosscut adit, 84 ft. lower, has been driven a distance of 146 ft. Owners estimate that an additional 70 ft. will be required to reach a point under the winze.

Country rock is a dark-green serpentinized schist containing stringers of quartz and calcite. Like the rock at the Sunny Hill mine, adjoining, it has probably been derived from dioritic rocks; but it is finer in grain than that seen at the Sunny Hill.

Bell Cow Prospect (No. 9) is a property of six unpatented claims in Sec. 35, T. 30 N., R. 9 W., 18 miles southwest of Ono, on Arbuckle Mountain. S. H. Fiske of Redding is now sole owner. Workings described in State Mineralogist's Report XXII have practically all caved and are inaccessible. A surface cut, 15 ft. deep, exposes a 20-inch vein with a strike of S. 39° E. and dip 74° SW. Work recently done under the supervision of J. Ashby Simpson includes a 117-ft. adit at a point on the hillside giving a vertical depth of 99 ft. below the cut just mentioned. A winze was put down on a faulted segment of a 2-ft. vein with a very flat dip, and this is badly crushed and broken. A second tunnel at a vertical depth of 65 ft. below the one just mentioned was driven by Simpson for 200 ft. or more, and is now being continued by Fiske. Total length at time of visit was 382 ft., and no veins were exposed. Other work done by Simpson includes a 491-ft. tunnel in the gulch 200 ft. lower than the present working tunnel, and a 180-ft. tunnel 225 ft. above the working tunnel. Neither of these cut any veins. Country rock is schist of various kinds, varying from a light-colored siliceous variety to a black graphitic variety.

Bibl: State Mineralogist's Reports XVIII, pp. 296, 493–94; XXII, pp. 169–70.

Benson Mine (No. 10) (Harmont Mining Syndicate) is a group of four unpatented claims, 72 acres, in Sec. 12, 14, T. 32 N., R. 6 W., held by Chas. Harvey, 53 State St., Boston, Mass. The distance from Redding by road is nine miles, of which six miles to Shasta is State highway, the balance rough dirt road. A discovery was made here in 1922 by George Zinn. Steve Benson of Shasta bought the property in 1929, and sold to A. C. Most and Harvey the same year. The Janice, Connection, Lost Shaft lode claims are held and the S. F. placer.

Gold is found in a fissure vein with a crushed quartz and gouge filling, associated with the intrusive contact of the quartz diorite into Copley meta andesite. The vein has an average width of 3 ft., maximum of 3½ ft. in the stope. James W. Halbrook, superintendent, states that it reaches a width of 9 ft. in a 65-ft. winze, which was full of water at time of visit. A lower working driven in the summer of 1932 is stated to have drained this winze. The vein shows for a length of 15 or 20 ft. in surface cuts, and crops again at a point 125 ft. east. The dip is 70° north. A crosscut adit cuts the vein 35 ft. below where it is exposed in the open cuts, and the 60-ft. drift and the winze mentioned above are driven from this. Above the drift is a stope 25 ft.

long and 10 to 15 ft. high. Benson states that he recovered $1,150 from ore from this stope, which averaged $15 per ton in free gold.

Equipment consists of a 2-cylinder, single-stage Rix compressor, capacity 110 cu. ft. per minute at 400 r.p.m. It is belt-connected to a 10-h.p. Doak engine, which drives it at 250 r.p.m. There are also an Ingersoll jackhammer, cars, rails and drills. A 15-hp. gasoline hoist is set up at the top of a hill, 350 ft. slope distance above the mine, to pull mine cars up to the truck road. Milling equipment consists of a 2-stamp mill, 350-lb. stamps, driven by a 3½-hp. gasoline engine, and a 5-stamp mill, 1200-lb. stamps, driven by a G.M.C., S-25 gasoline tractor. Treatment is by amalgamation, and there is a Wilfley concentrating table, 5 by 10 ft. with the larger mill.

Betty May Mine (No. 11) of eight claims in Sec. 8, T. 32 N., R. 6 W., was purchased, in 1929, by Ed. Ragos of Long Beach. At that time, a 12-inch vein was developed by means of a 135-ft. incline shaft, making an angle of about 45° with the horizontal, and 100 ft. of drifting at the 100-ft. level. Ragos stated that 50 to 80 tons of $50-ore was in sight. Equipment consisted of a 10-hp. gasoline engine driving compressor and hoist; also a 3½-ft. Huntington mill driven by a 7-hp. gasoline engine. Treatment was amalgamation. Ore is a white quartz containing iron and manganese oxides and free gold. Shortly after Ragos purchased the property work was discontinued, and the mine was idle until late in 1932, when F. G. Mauthe of Los Angeles started some new development work.

Black Bear Quartz Mine (No. 12) prospect consists of the E½ of Sec. 11, T. 31 N., R. 6 W., 320 acres patented, at Mule Mountain, 12 miles west of Redding. Mrs. Mae Helene Bacon Boggs, c/o Woman's Athletic Club, 640 Sutter St., San Francisco, is the owner.

Black Spider, see Jones.

Blue Danube Prospect (No. 13) is a property of three patented claims, 45 acres, M. S. 4681, in Sec. 12, T. 32 N., R. 6 W., owned by Mrs. Clara Archer of Redding. It adjoins the Benson Mine described above. Quartz veins are found associated with quartz diorite and alaskite porphyry. An assay map furnished by Mrs. Archer indicates values from $2 to $10 per ton in gold. Width where the $10-sample was taken is 3 ft. No work has been done recently.

Bluejay Property (No. 14) is near the Paymaster, and is held by the Gifford heirs. In the summer and fall of 1932, it was reported as being opened by Morris Collins of Lewiston. On account of this work being done late in the field season, the mine was not visited.

Boswell Prospect (No. 15) is a property of some 68 unpatented mining claims in Sec. 7, T. 31 N., R. 5. W., and adjoining sections, held by Mrs. Christine G. Stevens, and leased in 1932 to F. A. Zimmerman, 1060 Court St., Redding. It is seven miles west of Redding by dirt road.

In 1929, a company called Redding Consolidated of Nevada, 315 Montgomery St., San Francisco, held this property. W. G. Campbell was president, Chas. Joseph Carey was secretary, and G. B. Reed was general manager. A 112-ft. shaft was sunk near the outcrop of a quartz vein, and this vein was apparently cut in the shaft at about the 75-ft. level, but no drifting was done. Later thousands of dollars were spent on corrugated iron buildings, steel headframe, 50-hp. electric hoist, compressor, mill containing 8-ft. by 22-inch Hardinge ballmill, No. 3 Gates gyratory crusher, amalgamating plates, Wilfley concentrating tables, Deister slimers, etc. Apparently no mining was done after the machinery was installed, and it was later sold at sheriff's sale and removed.

Several veins of white quartz outcrop on the property. At a point 300 ft. west of the 112-ft. shaft is a one-foot quartz vein with an east-west strike. On this is an old stope 20 ft. long with an average height of about 10 ft. from an adit level to the surface. The vein is on the contact of a fine-grained andesitic dike, 10 ft. wide, in the quartz diorite. From this point, and extending over 100 ft. to the northwest is a strong outcrop of white quartz with an average width of several feet. Three hundred or 400 ft. farther to the northwest is a prospect shaft exposing 6 ft. of quartz with some brown staining due to oxides of iron. A quarter of a mile to the west a parallel vein, strike northwest, dip northeast, outcrops with a width of several feet of white quartz for a length of at least 500 ft. G. B. Reed and others have claimed to have traced this vein for more than a mile, but there are probably several breaks in the outcrops in that distance; and this makes it somewhat uncertain that the same vein is being followed. This vein is associated with the dikes in the quartz diorite, similar to the one already mentioned. Several prospect cuts have been made on this vein. So far as the writer knows, no systematic sampling of these veins has yet been made to determine gold values contained.

In the summer of 1932, F. A. Zimmerman and others were installing a mill of local design on this property. It consists of a number of 12-inch iron balls rolling around in a circular grooved ring. It is similar to the Ellis mill, but is larger and contains more balls. Treatment is to be by amalgamation and table-concentration.

Broken Hills Prospect (No. 16) is a group of four unpatented claims in Sec. 23, T. 31 N., R. 6. W., 12 miles west of Redding at Mule Mountain. It is reached by dirt road and one mile of trail. H. C. Christensen and C. W. George, both of Redding, are the owners. A 400-ft. adit runs east, and cuts two north-south veins with practically vertical dip. The first shows 4 ft. of quartz with abundant pyrite and arsenopyrite, which Christensen states assays $4 per ton in gold. The second shows 22 inches of similar material, which is stated to assay $11 per ton in gold. From the portal of the tunnel, it is 150 ft. to the first vein and 100 ft. farther to the second vein. Walls are diorite, but the workings are close to the intrusive contact of this into the Copley metandesite. Breccias and other contact phases are also present.

The larger vein is found on the surface, 500 ft. south of the tunnel, and is exposed by a shallow shaft and surface cuts for several hundred feet with widths of 2 to 3 ft. About 60 ft. west of the shaft is an open cut on a 4 to 6-inch quartz stringer, from which Christensen states that $3,000 worth of ore has been taken.

Broken Hills Silver Corporation (No. 17) was reported, in 1931, to have an option on the Paymaster Mine (which see). Apparently this option was not exercised.

Brown Bear Mine (No. 18) has the largest production record of the Deadwood and French Gulch districts, which are really one district separated only by the Trinity-Shasta county line. In 1930, the property was assessed to Thomas McDonald, R. A. Foster and Ella M. Smith, c/o Thomas McDonald, French Gulch, and comprised 589 acres of patented mining claims, of which 131 acres are placer, also several hundred acres of additional patented land, in Sec. 11, 12, 13, 14, 16, 24, T. 33 N., R. 8 W. The distance from Redding is 30 miles, 18 miles State highway, the balance beyond French Gulch being a winding dirt road with fairly steep grades. A longer route, via Lewiston, avoids some climbing, also avoids a summit, which is at times closed by winter snows.

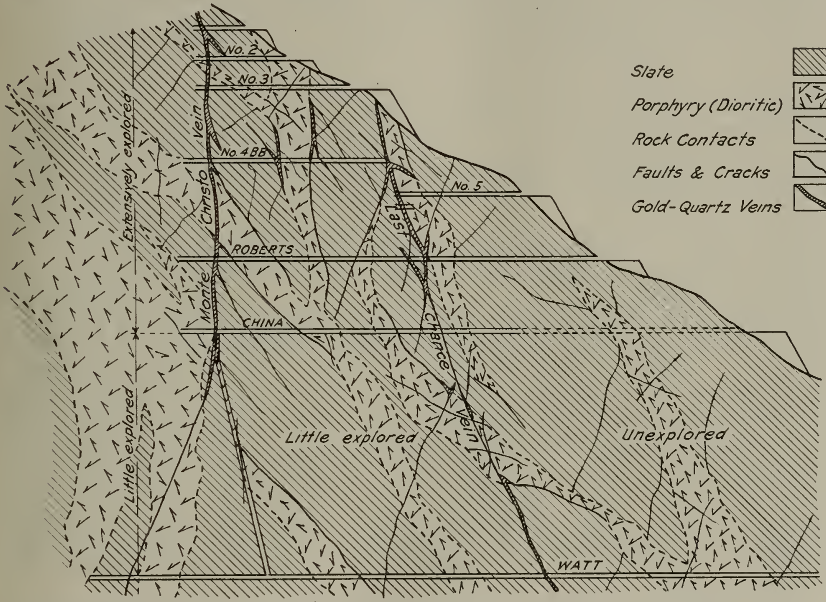
Slate
Porphyry (Dioritic)
Rock Contacts
Faults & Cracks
Gold-Quartz Veins
No. 2
No. 3
No. 4BB
No. 5
ROBERTS
CHINA
WATT
Monte Christo Vein
Last Chance Vein
Extensively explored
Little explored
Little explored
Unexplored

FIG. 2. Brown Bear Mine, generalized vertical section, looking east. Ore indicated above the China level has actually been stoped. Scale may be judged by distance from Watt level to level above—350 feet. (See description No. 18.) *Section furnished through courtesy of E. E. Erich.*

E. E. Erich of French Gulch is local representative of persons holding a contract to purchase the mine, and has been exploring and developing it for some time with a crew of about 15 men, in a search for new ore. He estimates[4] past gross production of the Brown Bear at $8,000,000 to $10,000,000, and states that he has definite detailed records of $3,000,000 of this. Three of its individual orebodies are stated to have produced in excess of $1,000,000 in gold each.

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[4] Erich, E. E., Mining Opportunities in Known Districts, Engineering and Mining Journal, Oct. 9, 1930.

The gold occurs in veins and fissures within an area of slate, which has been cut and intruded by porphyry masses and dikes. The principal rocks are the Bragdon slates, which are found in two distinct types, with some intermediate varieties. One of these is hard, siliceous and blocky, the other is soft, black and graphtic. Intruded into these slates are the diorite-porphyry and the soda-granite-porphyry, which have been described in detail by Ferguson[5]. Extensive fissuring of all of these rocks has occured, and it is along some of these fissures that gold-bearing solutions have passed, leaving traces and concentrations of gold. Some veins can be traced 1000 to 3000 ft. They parallel and also cut the inclosing rocks at acute angles in both strike and dip. They pinch and swell abruptly. In the expansions of the veins the filling is usually quartz, and at the ends or contractions the filling becomes more an admixture of quartz with slate or porphyry or both; and finally the vein pinches down to a gouge-filled fissure. Mineralized fissures cut through both slate and porphyry, usually carrying a few inches of quartz of a high assay value; but they are often not large enough to be mined at a profit except at intersections. The ore is white quartz carrying pyrite and sphalerite, a little galena and arsenopyrite, and free gold. The ore is usually of medium to high grade, varying from $10 to $1000 per ton. Sulphides amount to from 1% to 4% of the ore. The veins lie at varying angles but with a general east-west trend. There is a tendency to a reversal of dip on the lower levels, making the average dip nearly vertical. Principal production of the Brown Bear came from the Monte Cristo and Last Chance veins, explored 2600 ft. along their strike, and extensively mined to depths of 400 ft. Small portions of these veins have been mined to depths of 760 ft. below the surface. Several smaller veins have been explored near the surface, and have produced important amounts of high-grade ore. Both the Monte Cristo and Last Chance veins are strong fissures, with maximum widths of 20 ft; but in places they contract to a few inches of gouge. Ore was mined to a maximum width of 20 ft. and averaged between $20 and $100 per ton. The gold is not uniformly distributed throughout the veins, large portions of which contain only lean gold values.

The Watt tunnel, 350 ft. below the lowest of the old productive upper workings, had been driven 6000 ft. by previous operators into the general vicinity beneath the orebodies of the upper workings, and was then abandoned. This tunnel and some of the upper workings have been cleaned out and extended during present operations. Erich is proceeding with the idea that ore is likely to occur at intersections of fractures, particularly when one of those fractures is on the contact of the porphyry and slate. It is stated that on these contacts the slate is likely to bend when movement takes place, while the harder porphyry shatters, and open cracks result in the latter, forming a channel, which permits the passage of solutions. The structure of the slate has been studied by mapping strikes and dips, and this study indicates that folding of the slate has taken place, and that the outside crest of a fold occurs within the main workings of the mine. This is believed by the operators to be important, because stretching and shattering of the slate at the outside of the fold may have opened channels favorable to the deposition of ore. In connection with this study of the mine a plan model on sheets of glass, on a scale of 100 ft. to the inch, has been constructed; also models made up of vertical sections on sheets of celluloid, on a scale of 200 ft. to the inch. A plan or section is made through the mine for each 100 ft. and these are combined to form the models.

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[5] Ferguson, H. G., U. S. Geol. Survey Bull. 540-A, pp. 24–25, 1913.

Total length of the workings in this mine amounts to 30 miles, and time alloted to this report does not permit of a detailed description of them. Such a description would involve the reproduction of a large number of maps and sections. The mine is well equipped with air compressor, machine drills, buildings, etc. The 10-stamp mill was in operation late in 1932.

Bibl: State Mineralogist's Reports VIII, p. 639; X, p. 713; XI, pp. 483–84; XII, p. 308; XIII, pp. 440–41; XIV, pp. 885–86; XXII, pp. 15, 16, 28. U. S. G. S. Bull. 540, pp. 70–71. Eng. & Min. Jour. Vol. 130, No. 7, Oct. 9, 1930, pp. 333–34.

Buena Vista Prospect (No. 19) is a property of three unpatented mining claims in Sec. 5, T. 31 N., R. 5 W., five miles by road west of Redding. It was discovered by A. Abel about 1927, and is now held by H. G. Graves, 1732 Sixth Ave., Oakland, Cal. Art Thompson, address Redding, lives on the property.

An incline shaft has been driven on the vein, the upper 50 ft. at an angle of 30° from the horizontal, and the lower 60 ft. at an angle of 45° from the horizontal. At the 50-ft. level some faulting is evident. Drifts on this level are 38 ft. long to the north and 15 ft. to the south. At the bottom of the shaft is a drift of 40 ft. to the south. The vein averages about 5 ft. in width above the fault at the 50-ft. level, and consists of quartz and sulphides, partly oxidized, including a little chalcopyrite. Oxidation of this has produced some green staining. Below the fault, the average width of the vein is 2 ft., and the green staining is absent. Art Thompson, who did the work, thinks that this is a different vein from that in the upper part of the shaft. On the surface there is evidence that such a vein exists in the hanging wall at a distance of a few feet from the main vein. Thompson states that vein material exposed averages $30 per ton in gold. To the east of these workings, at a distance of about 1000 ft. a second quartz vein outcrops with a maximum width of 6 ft. and an average width of two feet. A 50-ft. tunnel has been driven on this. Thompson states that the assay value is $5 to $6 in gold. Equipment at the main workings consists of an 8 by 8-inch single-stage compressor belted to a 40-hp., 4-cylinder gasoline engine of marine type; also a one-cylinder, 15-hp. gasoline hoist.

Country rock is Copley meta-andesite, intruded by dikes. Just to the west of the main workings, an andesitic dike containing phenocrysts of plagioclase feldspar $\frac{1}{8}$ inch long, and smaller phenocrysts of altered biotite in a fine-grained green groundmass, was noted. What appeared to be the outcrop of a dike of rhyolitic rock of very fine grain was seen to the east of these workings.

Bully Choop Mine (No. 20) in Sec. 4, 5, 8, 9, T. 31 N., R. 8 W., adjoining the Cleveland mine on the Shasta-Trinity county-line, has until recently been assessed to Bully Choop Gold Mining & Power Co., 805 Atlanta Trust Building, Atlanta, Georgia. The patented land, about 200 acres, of this company has now been deeded to the State of California for five year's delinquent taxes. Five of the unpatented claims have been relocated by H. E. Upham and D. S. Upham of Douglas City. The elevation is 5000 ft., and steep mountain roads reach it from either side of Bully Choop Mountain. From Redding, one route is by 25 miles of county road to a point 8 miles west of Ono, then 16 miles of steep, narrow, winding, mountain road to the Cleveland mine, and a mile or two more over the summit to the Bully Choop. The other route is by 40 miles of State highway to Douglas City, then 16 miles mountain road to the Bully Choop mine.

A large amount of money was spent some years ago to equip this property (see State Mineralogist's Report XIV for 1913 and 1914). Roads were built, also dwellings, sawmill, electrical plant, 15-mile telephone line, and 30-stamp mill driven by water and electrical power. Water for power was obtained from the north and south forks of Indian Creek through a 3-mile ditch. Several thousand feet of mine workings were driven and some production resulted. Old workings are largely caved now, but the No. 2 level can be entered, being only partly caved at the portal. It is a crosscut adit reaching the Bully Choop vein 300 ft. south of the portal, and this was stoped for a length of several hundred feet to a width of 3 ft. The dip is about vertical. Roughly 300 ft. farther south, the Occidental vein is cut. This is a quartz stringer-zone in the hornblende schist, and has been stoped for a length of 200 ft., and widths of 15 to 20 ft., to the surface, roughly 150 ft. above. No. 3 level is partly caved at the portal but could be entered if a set or two of timber were replaced. According to H. E. Upham, this level reached the Bully Choop vein, and considerable work was done on it; but it did not reach the Occidental, and about 50 ft. of work will be required to reach the latter. No. 7 level (caved), 1000 ft. lower in elevation, is stated not to have reached either of the veins mentioned, but considerable stoping was done on a third vein. The old 30-stamp mill of 1050-lb. stamps is still on the property, also a 4½-ft. Huntington mill, rails, cars, etc.

At the time of visit in July, 1932, Upham brothers had been working for two weeks on their locations. Work was stated to be on the Occidental claim. Several small open cuts had been made on stringers near one end of the stope where the Occidental vein was worked to the surface. The greatest depth reached was about 10 ft. below the surface. The stringers are about vertical and vary in width from a few inches to two feet. The best ore is in a white quartz heavily stained with yellow and some red ochre; and vugs and cavities are filled with these iron oxides from the oxidation of the original sulphides. This ore pans well in free gold. Occasionally specks of free gold can be seen in the white quarts away from oxides of iron. Plans called for the immediate milling of some of this ore in the Huntington mill, with treatment by amalgamation.

Country rock is hornblende schist, which is not very uniform in composition here, and appears to be the result of pressure acting on a variety of igneous rocks, with some recrystallization. Original rocks were probably mostly diorites and gabbros, but in one wall of the Occidental vein is a rock that apparently was a dike of 'bird's eye porphyry'. It contains white remnants of feldspar crystals, a quarter of an inch long, in a groundmass of brown micaceous material, which shows the schistose structure.

Bibl: State Mineralogist's Report VIII, p. 640; XII, p. 308; XIII, p. 441; XIV, p. 886; XX, p. 182.

California Progressive Mining Co., see Clipper and Snyder.

Calmich Mine (No. 21) (Lappin) is a group of four patented claims assessed to Mary F. Bacon and others, 60 S. San Rafael Ave., Pasadena, California. It is in the Deadwood District in Sec. 13, T. 33 N., R. 8 W., at an elevation of 3500 ft., and is reached by means of about a mile of steep mountain road starting at the lowest mill-level of the Brown Bear mine. Harvey Clayton and H. E. Kimmel of Lewiston are leasing the property. Clayton states that former operators extracted a shoot 90 ft. long, with 200 ft. of backs, from a vein averaging 6 inches wide, and with a maximum width of 10 inches. Ore was treated by amalgamation, and the recovery is stated to have been $60 per ton. Another irregular shoot with a maximum length of 30 ft. was extracted. The strike is east and west, dip north, and the shoot raked to the east. Clayton and Kimmel have sunk a 40-ft. shaft from an upper tunnel level on an average incline of 60° from the horizontal, and have driven a 15-ft. crosscut from the bottom. Within the next 10 ft. they expected to hole into a place into the old workings, where they stated that some good ore was exposed. The shaft and crosscut are in hard slate. A two-stamp mill and 4½-hp. gasoline engine have been installed. Treatment is amalgamation.

Calumet Mine (No. 22) is an old patented property of three claims in Sec. 10, T. 32 N., R. 5 W., assessed to Mrs. Mary B. Garlick, 2243 Franklin St., San Francisco. W. D. Tillotson of Redding is local representative. The ground covers extensions to the south of quartz veins found at the Walker property in the Old Diggings District. Quartz outcrops with widths of 4 ft. and occasional swells to double that width can be seen on the property. Workings are largely caved. No mining has been done here for many years.

Bibl: State Mineralogist's Reports VIII, p. 563; X, pp. 631–32; XI, pp. 43, 395; XIV, p. 781.

Central Mine (No. 23) is a group of four patented claims and a millsite in Sec. 3, 4, T. 32 N., R. 5 W., and 33, 34, T. 33 N., R. 5 W., owned by A. A. Anthony and others of Redding. It is 11 miles by road north of Redding, and is just across the Sacramento River from the main north-south line of the Southern Pacific railroad.

Workings of this property are caved, and can not now be entered; but it is of considerable interest as a possible member of a large group in the Old Diggings district. Possibilities of grouping the properties of this old district are discussed further under the heading 'Old Diggings.' Outcrops of some of the veins can be observed on the surface. The following description of the vein-system and workings is quoted from Logan[6]:

> "There are four veins on the property, three of which strike north and dip 65° east and the fourth strikes east. Work has been confined to the north-striking Central vein, which has been mined through adits. The lowest of these is the only one now accessible. It is a crosscut to the west for 956 ft., where it cut the

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[6] Logan, C. A., State Mineralogist's Report XXII, pp. 170–171, 1926.

vein and thence followed it north about 650 ft. and also followed it southward until it pinched. This level gave about 335 ft. of backs, and known ore above it has been stoped. One stope in the north drift was 150 ft. long, 30 ft. high and 10 to 15 ft. wide. There was six feet of solid quartz on the footwall, the balance of vein being a stringer lead. The country rock is altered andesite. On the south, about 400 ft. of work failed to develop ore. On this side, the vein pinched down to nothing.

"This adit was run from about the center of Central Extension claim, through the Central claim to within 400 ft. of the north end-line. About 300 ft. west, on the Shasta claim, is the parallel Shasta vein, and the Pocket vein, also striking north, lies 250 to 300 ft. east of the Central. The east-striking vein crosses the north end of claims, 300 to 400 ft. north of the present face of Central adit, depending on dip of east-striking vein, which at the surface is about 45° north.

"In the earlier work between 1885 and 1895 Huntington mills were used for crushing ore, the millsite being on the river some distance from the mine. It was found that only about 50% of the gold was recovered by this method. Later, shipments to Selby smelter, Keswick smelter and finally to Kennett were made. The total output is estimated at about $500,000, but smelter receipts for much of this have been lost. Receipts in Anthony's possession for shipments to the Keswick smelter between 1900 and 1906 show assay values ranging from $3.40 to $84 a ton, little of the ore going below $6 a ton, and the average for six years being over $13 a ton. Of course, much lower grade ore was shipped later, as it could be cheaply worked and delivered, and the quartz was worth $2 a ton as flux alone. A tramway delivered ore from the mine to railroad.

"The lower part of this mine could be prospected to advantage from the Reid Mine shaft, which is nearby. There is no equipment at the Central."

Bibl: State Mineralogist's Reports VIII, p. 565; X, p. 631; XII, p. 246; XIII, p. 351; XIV, p. 782; XVIII, p. 494; XXII, pp. 170–71.

Chanchelulla Prospect (No. 24) is a group of eight unpatented claims and a millsite in Sec. 1, T. 30 N., R. 10 W., held by David Boyer and F. W. Forrester, both of Ono, Shasta Co., Cal., and D. L. Martin, c/o Harry Glover, Redding. It is 60 miles by road west of Redding, county road to Harrison Gulch or Knob (P.O.), then narrow, winding mountain road with fairly steep grades to Deer Lick or Combs Springs, then one mile steep mountain trail to mine, which is at elevations of from 3000 to 5500 ft. The millsite is on a fork of Browns Creek, which flows a good stream.

A 3- to 4-ft. quartz vein, exposed in open cuts and one 50-ft. adit, strikes S. 50° E. and dips 47° SW. Forrester states that this has been traced for the length of four claims, 6000 ft.; but it is doubtful that the vein could be opened with widths as great as indicated above for this entire distance. Cuts to a total number of 10 expose the vein at various points for the length of these four claims. Depths vary from one foot to 10 ft. The 50-ft. tunnel reaches a depth of about 50 ft. on the vein. A second vein, one foot wide, called the Shaft Vein, is opened by means of an incline shaft, 17 ft. deep. The strike is S. 30° E., dip 30° SW. This shaft is 75 or 100 ft. northeast of a point on the main vein, and hence intersections on both the strike and dip are indicated. Forrester states that this vein assays $16 to $20 per ton in gold and a few ounces in silver. Both walls of the Shaft Vein are gabbro-schist or gneiss, and the hanging wall of the main vein is of this formation also. The footwall is a breccia, white in color, and probably rhyolitic. It contains quartz fragments of a maximum size of three-quarters of an inch in diameter.

Cleveland Mine (No. 25), on the Shasta-Trinity county line in Sec. 9, 16, T. 31 N., R. 8 W., is the property of the C. F. Foster Co., of Corning. It has been optioned for some time to C. J. Kerr and associates of Redding and Eugene, Oregon. In area it totals 800 acres of patented ground, all of Sec. 16, and patented mining claims, Gen. Washington, Ida M., etc., to make up the balance. By road it is

42 miles west of Redding, 25 miles of county road to a point eight miles west of Ono, 17 miles of steep, narrow, winding mountain road to mine, which is at an elevation of 5500 ft.

A quartz fissure vein carrying plentiful sulphides of iron at shallow depth, some arsenic and a little copper, has been mined for gold. A little free milling ore was found at the outcrops. Following along the outcrops for 1000 ft. or more, one sees pinches and swells in the vein, which varies in width from a few feet to 20 ft., average 8 or 10 ft. The strike is N. 9° E. and the dip 60° E. Exposures in outcrops and tunnels in this upper part indicate a length of about 2500 ft. C. J. Kerr states that a vein corresponding in strike, and in the right position for the dip, is found on Jerusalem Creek, 2000 ft. lower in elevation. If this is the same vein, a length of 3500 ft. is indicated. Country rock is a complex schist series, mica-schist and diorite- or gabbro-gneiss. One small lens of limestone was noted.

No. 1 tunnel starts on the outcrop, and is 140 ft long. From this a winze 60 ft. deep has been sunk, and some stoping has been done on a width of 6 ft. of quartz. No. 2 tunnel, 150 ft. lower and 400 ft. long, is caved. No. 3 tunnel, 50 ft. below No. 2, is 425 ft. long, part crosscut and part drift, from which the vein has been stoped out. The vein can be seen, continuing to the south at the south end of the stope, with a width of about 4 ft. of quartz, with no drifting on it. To the north, in the face of the tunnel, the vein is disturbed by faulting; but it can probably be picked up again with a small amount of work. A winze, 75 ft. deep, from this level is full of water. No. 4 tunnel, 258 ft. below No. 3, is 820 ft. long, and is entirely in country rock. It was started to tap the vein at a point under the winze from No. 3, but according to present operators it must be driven 200 ft. farther to reach that objective. At time of visit, work had been confined to cleaning old workings. An old 10-stamp mill operated here years ago is in a wrecked condition.

Bibl: State Mineralogist's Reports XII, p. 310; XIII, p. 442; XIV, p. 887.

Clipper and Snyder Group (No. 26) is an old group of patented claims assessed to California Progressive Mining Co., 126 Folsom St., San Francisco, and located in Sec. 36, T. 34 N., R. 6 W. It is reached by eight miles of trail starting at the Squaw Creek bridge about a mile west of Kennett. When the Uncle Sam mine was visited, in the summer of 1932, short stretches of this trail were in poor condition, so that a horse could not get over them. Workings of the Clipper and Snyder are caved, and the property was not visited during the present survey. The following information is from a report by Melville Atwood, dated Sept. 21, 1914, and handed to the writer by C. R. Hussey, who states that he has controlling interest in the corporation. The Snyder vein is stated to be 3 to 4 ft. and more in width. On this were a No. 1 level, 125 ft. long, a No. 2 level, 310 ft. long, exposing the vein with widths of from 2 to 6 ft., and a No. 3 level, 360 ft. long exposing similar widths. The yield is stated to be from $5 to $9 per ton including sulphurets and specimen-ore. A run of 415 tons in the ten-stamp mill of 850-lb. stamps is stated to have yielded in the mill $4183, and in specimens shipped to the smelter $12,300. The Lillian Maude vein is stated to show one to one and a half feet of $20-ore. The Carrey Huston vein is stated to be 2 to 6 ft. wide and more, with a 525-ft. tunnel on it. Ore from the entire length of this is said to have averaged $9 per ton.

The Clipper vein was developed with a 326-ft. tunnel, and 140 ft. from the portal, a 44-ft. winze, which exposed a vein 6 ft. wide for the entire distance. Ore from this winze is stated to have assayed $10 per ton, and from the top of the tunnel $8 to $30 per ton. Ore is stated to contain 1½ to 2% of sulphides assaying $150 to $300 per ton.

Bibl: State Mineralogist's Reports X, pp. 640–41; XI, p. 399; XII, p. 246; XIV, p. 781.

Craig, see Mason and Thayer.

Crown Point and Midnight (No. 27) are two patented claims in Sec. 13, 24, T. 31 N., R. 6 W., assessed to C. H. Hammond, W. 328-8th Ave., Spokane, Washington. They are ten miles by county road southwest of Redding, the last mile of road not being passable by auto at present. A quartz vein with widths of 4 and 5 ft. strikes northwest and dips 50° to the northeast. A 150-crosscut adit cuts the vein at a point which gives backs to the surface of 100 ft. From the crosscut there is 50 ft. of drifting and a raise to the surface. A small amount of ore was stoped here and shipped to the Keswick smelter years ago, but the results are not known. The ore is a white quartz containing pyrite. On the hanging wall is a streak of six inches or more of dark green gouge, which also carries sulphides of iron. H. C. Christensen recently concentrated some of these sulphides by panning, and had the concentrates assayed. He states that the return was $22 per ton in gold. The workings described are on the Midnight claim. To the northwest, at a distance of 1000 ft., just across the property line on ground held by Geo. P. W. Jensen, 320 Market St., San Francisco, and leased to H. C. Christensen of Redding, is an incline shaft on the same vein, open for 40 ft., but full of water below. To the south, on the Crown Point claim is a shaft on the vein, now caved. The vein may be seen in a road-cut nearby. Christensen has recently cleaned out a 150-ft. tunnel here, and started on the shaft.

A peculiar dike was observed on this ground, apparently a coarse-grained igneous rock with quartz crystals from a quarter of an inch to a half inch in diameter. This appears to have been a dike in the Copley meta-andesite, and to have been subjected to great pressure with the meta-andesite, so that it now resembles some of the older schists of the region. Some of it has abundant muscovite on the cleavage planes. The Copley meta-andesite has been subjected to such great pressure here that much of it resembles slate, except for the green color.

Democrat Group (No. 28) contains 15 unpatented claims, 280 acres in Sec. 12, 13, T. 33 N., R. 10 W., 1½ miles from Weaverville on the ridge between West Weaver Creek and Democrat Gulch, held by R. H. Junkans, C. J. Hanna and D. E. Ryan of Weaverville. J. W. Shaw has recently cleaned out a 340-ft. tunnel, cutting sandstone, then a serpentinized dike, then an andesitic dike. The last 50 ft. is in schist, most of which is light green and chloritic appearing, but there are layers of graphitic schist. The strike is N. 35° E., and the dip 45° NW in the face, but considerably flatter than that in other parts of the tunnel. The schist carries lenses and veins of bluish quartz showing sulphides of iron, which is stated to have been very productive of gold on parts of the surface and in the placers nearby.

On the opposite side of the ridge (west fork of Weaver Creek side), at a point 1600 ft. east of the tunnel mentioned above, and 150 ft. lower in elevation, is a second old tunnel, 160 ft. long, in the schist. At the face is a width of 14 ft. of quartz heavily mineralized with sulphides of iron. Samples were being taken of this at time of visit, but the results were not learned.

Bibl: State Mineralogist's Report XXII, pp. 17, 29.

Dixie Queen (No. 29) is a group of three unpatented claims and a fraction held by Melvin A. Taylor, 809 Eighth Avenue, Oakland. It is located in Sec. 14, 23, T. 32 N., R. 9 W., on Spring Gulch, a tributary of Indian Creek, reached via Douglas City. A road has been started to go up Spring Gulch from Indian Creek, but it is not yet complete. This property is stated to have produced $5,000 worth of a base shipping ore, containing gold, silver, lead and zinc, worth $200 per ton and over, from a shoot 120 ft. long and 40 ft. high to the surface. At time of visit, John de Cordi was working on this same vein on an 8-inch width of ore, said to assay $30 per ton. Total length of working adit was 300 ft. Equipment consisted of an arrastre operated by water power with an 80-ft. head, used in a one-inch nozzle. Treatment was by plate-amalgamation.

Bibl: State Mineralogist's Reports XIV, p. 887; XXII, pp. 17, 29.

Double Header Mine (No. 30) is an 80-acre tract of patented land bought from the railroad in Sec. 33, T. 33 N., R. 7 W., and is assessed to Chas. Garrett of Schilling and Wm. P. Donnelly of Anderson. It is on the Redding-Weaverville State highway, 20 miles west of Redding. Some production was made here in 1888, at which time a 5-stamp mill was operated. The ore was produced from surface workings on the contact between slate and decomposed Copley meta-andesite. At a point 150 ft. below these old workings, a tunnel was driven by the old company, and the surface near the portal produced some good ore; but most of the 400 ft. driven at that time was a low-grade vein with both walls of Copley meta-andesite. The strike is a little east of north, dip 45° east, and the width varies from a few inches to 5 ft. of quartz. In 1931, Garrett let a contract for driving this drift-tunnel ahead for 120 ft. on the vein, in the hope of reaching a part with a slate hanging wall. Walls are both Copley meta-andesite in the new part of the tunnel, and at time of visit the vein had not yet been sampled. The 2-stamp mill, with 6-hp. gasoline engine, has not been used recently.

Bibl: State Mineralogist's Reports VIII, p. 567–68; XVIII, pp. 138, 354, 405; XIX, p. 11.

Eastman Con. Mines Corp.—see Venecia.

East View (Winnie) (No. 31) comprises three unpatented claims in Sec. 6, T. 32 N., R. 6 W., held by Chester Vergnes of Oak Bottom. It is just north of Oak Bottom, which is 12 miles west of Redding on the Weaverville highway. A quartz fissure vein, which varies in width from one inch to two feet, is developed by means of a 500-ft. adit, of which 100 ft. is on the vein, giving a depth of 50 ft. below the surface. It is stated to contain good values in gold. From the opposite side of the hill to the workings mentioned above, a crosscut adit has been driven for a distance of 40 ft. Country rock is Copley meta-andesite cut by quartz-diorite dikes.

Eiller Mine (No. 32) consists of four unpatented mining claims in Sec. 11, T. 32 N., R 6 W., held by H. M. Huse, O. E. Stone and Dr. H. E. MacDonald of Redding. From Redding it is 10 miles by road; the first 6 miles to Shasta is State highway; the balance of 4 miles is rough dirt road; and the last mile is very steep.

When Dr. Bell and brothers held this property in 1880 to 1889, a 400-ft. adit was driven; and about 125 ft. lower in elevation, a second adit thought to be 1900 ft. long was driven. At that time the mine was equipped with a mill of two 1000-lb. stamps and a canvas plant, which was probably used very little. In 1928–1929, the Gold Hill Mining Co., with A. C. Marr in charge, cleaned out and retimbered 700 ft. of this lower tunnel. According to H. M. Huse, at this 700-ft. point the tunnel exposes a width of 11 ft. of quartz that assays $1.00 per ton in gold. He thinks that the grade improves beyond this point. At the present time, a small cut exposes a quartz vein, 3 ft. wide, heavily mineralized with oxides of iron, from which good pannings in gold can be obtained. The strike is about east and west and the dip vertical. At a point 75 ft. lower in elevation than the cut, or at the same elevation as the 400-ft. adit (caved) mentioned above, and at a distance of 100 ft. from the latter, a new adit was being driven at time of visit by O. E. Stone and two other men. The course of the adit was southwest for 42 ft.; it then turned to the right to follow 6 to 8 inches of gouge with occasional bunches of quartz, which was thought to represent the 3-ft. vein at this level. Drifting was being continued to the west to reach a point under the surface-cut, 50 or 75 ft. ahead. Country rock is quartz diorite, and there is a rhyolitic dike 200 ft. southwest of the workings. Equipment consists of a cook-house and a bunk-house to accommodate 10 men, and a blacksmith shop.

Ellis (No. 33) is a single patented claim of 15.8 acres in Sec. 6, T. 33 N., R. 5 W., assessed to L. C. Monahan of Berkeley and M. E. Dittmar of Dunsmuir. According to Dittmar, the long adit starting in the Bonanza claim of the Uncle Sam group, and running northeasterly, cut a vein in the Ellis claim showing 18 to 20 inches of quartz and chalcopyrite that assays $8 in gold and silver, and 2½% copper. This adit was run by the American Zinc, Lead and Smelting Co. of St. Louis in a search for extensions of ore bodies in the Mammoth mine. The face is at a point 700 ft. southeast of the northwest corner of T. 33 N., R. 5 W., M. D. M. (a township corner). Backs on this vein from the point where cut to the surface are stated to be over 1300 ft.

Bibl: (American Zinc, Lead and Smelting Co.) State Mineralogist's Report XIX, p. 57.

Evening Star (No. 34). A claim of this name, 18 acres, is held by Wm. Blagrave of French Gulch. It is between holdings of the Washington and Milkmaid in the French Gulch District.

Evening Star (No. 35) a group of this name will be found shown on the map included herewith under the heading 'Old Diggings District.' No work has been done on the group recently but it is interesting as a possible member of a large group that could be formed in the district mentioned. It was formerly held by Geo. Bayha and W. D. Tillotson of Redding, and is patented ground.

Bibl: State Mineralogist's Report XIV, p. 786.

Evening Star (No. 36) formerly Bright Star or Iron Mask, is a property of three claims in Sec. 30, 31, T. 33 N., R. 6 W., held by W. H. Reel of Schilling, and Mrs. Mabel Barndt, Ivanhoe Hotel, Berkeley. It is just west of the Mad Mule.

A crosscut adit cuts the vein at a distance from the portal of 190 ft. The vein strikes about north and south, has a steep dip to the east, and a width of from one to 3½ ft. of quartz. There is 600 ft. of drifting on this level, and a pay-shoot 60 ft. long. A winze was started on this pay-shoot; but at a depth of 30 ft. it passed out of the shoot, which has a rake to the north. There is a level at 125 ft. with drifts to the north of 130 ft., and to the south of 100 ft. At a distance of 60 ft. from the winze in the north drift, a raise was put up; and this struck the pay-shoot. W. H. Reel states that he did this work, and that the face of the raise showed specimen ore, none of which was stoped. The width of the vein was 18 inches, and it appeared to be widening to the north in the single drift-round that was put in. There is a cave on the main tunnel level at the collar of this winze, and none of this lower work can be examined at the present time. Above the main level, the pay-shoot is stoped out. The vein is on the contact of slate with alaskite on the main level for a short distance, the balance having both walls of alaskite. A parallel vein, similar in general appearance at a distance of 25 or 30 ft. has been exposed on this level, and can be seen in a short drift. Nothing has been done in these workings for years, assessment work being above in an open cut on a small stringer.

Bibl: State Mineralogist's Reports XII, p. 250; XIII, p. 359; XIV, p. 780. U. S. G. S. Bull. 540, p. 55.

Fairview Mine (No. 37) comprises 520 acres of patented mining claims and 330 acres of unpatented claims, including quartz claims, placer claims and mill sites, in Sec. 3, 10, 11, T. 34 N., R. 8 W., assessed to Fairview Mining Co., Room 1406, 315 Montgomery St., San Francisco. It is on the Trinity River 10 miles north of Lewiston, but from the road along the river it is accessible by foot-bridge only. A steep mountain road connects the mine with Trinity Mountain Ranger Station, north of French Gulch. The mine has been worked at various times for many years, in 1901 to 1908 by the company, later by different lessees.

At time of visit, in June, 1932, lessees were Don Matheson and Max Jacobs of Lewiston, and J. Mackey of French Gulch. At an elevation 650 ft. higher than the lowest adit level (No. 4), they were driving an adit to cut a faulted segment of the vein, that had been developed by surface cuts just to the east of the point where the east end of the old stopes came to the surface. The adit had been driven 100 ft. by the three men working on three different shifts, at the rate of 8 ft. per day, with hand drilling. Sixty feet more was expected to be sufficient to reach the segment of the vein, with 50 or 60 ft. of backs. From the open cuts above, ore had recently been mined; and it was treated in a 3-ft. Huntington mill equipped with amalgamating plates. At the portal of No. 4 adit, is a 90-cu. ft. compressor driven by a one-cylinder gasoline engine. Of the old 40-stamp mill, 10 stamps still remain on the property, but they are not in working order.

The vein strikes in a general easterly and westerly direction, and dips to the north at angles of 60° and greater. It has been stoped out for a vertical height of 450 ft. from a shoot having a flat rake to the east. Stopes are several hundred feet long, and average about six feet in width. The No. 4 level, the lowest that has been driven, is 200 ft. below the lowest stoping, and several hundred feet higher than Trinity River. It is the only level now open, and is 1700 ft. in length. Lessees have recently cleaned out an old 30-ft. raise near the face, raised an additional 70 ft., drifted 65 ft. east from the top of this raise, and raised another 30 ft. from the face of the drift. This work has exposed some vein material dipping south, or opposite to the normal dip of the vein. Some of it has been of very good grade, but the vein material has been very irregular and difficult to follow. The width is about 2 ft.

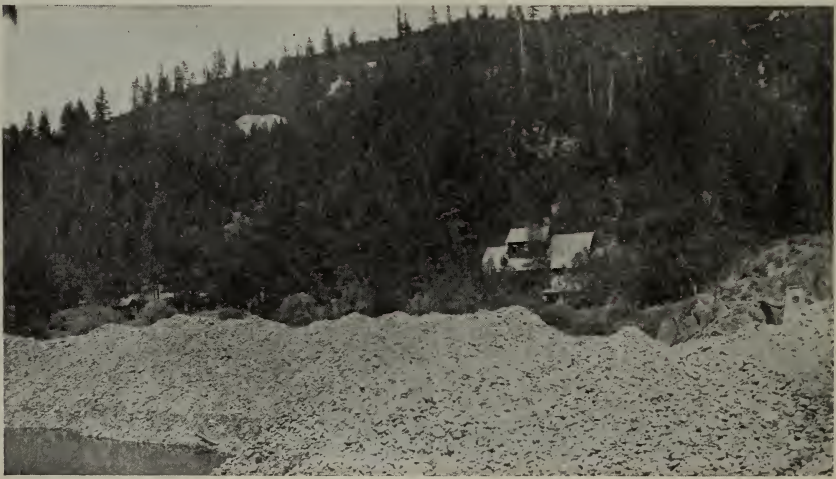

FIG. 3. Fairview Mine. Tailings from Lewiston Dredge in foreground. (See description No. 37.)

Both walls of the vein are black slate. A fault-contact of this with the meta-andesite is exposed on the No. 4 level, but no ore has been found on such a contact. The ore recently found in the raise above No. 4 level appears to have associated with it a dike rock. This is very dark in color, perhaps due to an admixture of black slate. Crystals of free quartz indicate that it may have originally been rhyolitic. Alteration and silicification make its composition obscure. Some of it has a brecciated appearance.

Bibl: State Mineralogist's Report XIV, p. 888. U. S. G. S. Bull. 540, pp. 75–76.

Fields-Meckel Prospect (No. 38) an unpatented group on the south slope of Weaver Bally, at an elevation of about 6000 ft., is held by Dr. D. B. Fields of Weaverville and A. C. Meckel. The property has been visited by the writer, but caving at the portal of the main adit prevented examination of the workings. Logan[7] has described these as follows:

> The lowest adit is at 5810 ft. elevation and follows the vein N. 75° E. for a distance of 230 ft. The vein is from six inches to two feet wide and forms small lenses of solid white quartz, the longest of which is 35 ft. long. There is a raise 32 ft. above the adit. The vein is tightly frozen to both walls, which are hard hornblende schist. The best showing so far on the property was at the portal of this adit, where $2500 is said to have been extracted from a hole two feet deep on the vein. The vein shows six inches of quartz at the face, and is said to pan well in free gold as far as drifted. It shows free gold in places. There are three other adits, the lowest, now caved, being 50 ft. below the one described, and two short ones recently started 100 ft. and 150 ft. above the main adit. All these are in an area of a few acres and the rest of the claims are unprospected except for shallow pits, although the vein is said to be traceable for 2000 ft. Assessment work only is being done, and there is no equipment except hand tools.

Bibl: State Mineralogist's Report XXII, pp. 19-20, 29.

First National Copper Co., see Balaklala.

Fisk, Jim, see under 'J.'

Five Pines Mine (No. 39) comprises 80 acres of patented land and five unpatented mining claims in Sec. 19, 20, T. 35 N., R. 7 W., 40 miles by road north of Redding, owned by Van Ness Brothers of French Gulch. The mine has been a good producer at intervals since its discovery in 1896 by H. J. Van Ness. The gold is found in pockets associated with a slate-andesite contact. Lester Van Ness estimates the total production at $350,000 to $400,000, and states that the largest pocket yielded $44,000. The ore in these pockets is very rich, and it is estimated that 60% of the total production has been made from ore that was pounded out in a hand-mortar.

The slate-andesite contact strikes southeast and dips 45° to the northeast. The main vein strikes east and west, and has a very steep dip to the north. This is a former fault fracture, which displaces the slate-andesite contact about 20 ft. The vein averages $4 to $7 per ton where both walls are andesite, but a rich shoot with a flat rake is found where the vein cuts the slate-andesite contact. In addition to this main vein there are a number of parallel stringers which also form rich pockets at the intersection with the contact mentioned. The andesite is very fine-grained gray igneous rock, with individual crystals too small to be identified without a microscope. The slate is a soft, black variety, that contains a large amount of graphite.

On the Surprise claim is a 450-ft. drift adit, which reaches the collar of an inside shaft or winze. This was started in the slate, 32 ft. from the contact, out in the hanging wall; but the contact flattened, and the lower part of the winze is in andesite. There is more than 1000 ft. of other work on this main level, partly caved. James Skeen, of Redding, deepened the incline winze, in 1926, from the 200 to the

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[7] Logan, C. A., State Mineralogist's Report XXII, pp. 19–20, 1926.

300-ft. level, and did 125 ft. of drifting on a stringer, which was stoped; and some high-grade was taken out. The main vein has not been developed below the 100-ft. level. It will require 300 or 400 ft. of work to reach this vein on the 300-ft. level. Equipment here consists of an Ingersoll-Rand 4-drill compressor, a large Sullivan portable compressor, three Cameron sinking pumps, the largest being No. 6, and complete hoisting equipment on the winze. No work has been done here recently, and this equipment is not in use. Water stands in the winze to within a short distance of the main adit level. A small mill consisting of crusher, ball mill and amalgamating plates stands here also, but it was not a success in treating the ore. A two-stamp mill stands on another part of the property.

On the Emma claim two men are working above a 300-ft. adit near creek level. East-west veins cutting the slate-andesite contact are being explored by means of various raises and drifts above the adit. Free gold associated with calcite and arsenopyrite is found in pockets near this contact, and some production is being made from ore crushed in a hand-mortar. Rich pockets come at the intersections of stringers with the slate, especially if the stringers have an abrupt change in direction near such an intersection. Three men are working in a narrow channel below the mine, but on the same property, for placer gold. This channel extends for at least three-quarters of a mile below the workings on the Emma claim, and is 35 ft. wide and has an 8-ft. depth of gravel, which is stated to average 50c per cubic yard. The gold is partly quite coarse, a $3-piece and an $8-piece having been recovered recently. Lester Van Ness says that in earlier years, one 14-ounce piece and several one-ounce pieces were recovered.

Bibl: State Mineralogist's Reports XIV, p. 889; XVIII, p. 355; XXII, pp. 20, 29. Pre. Rep. No. 8, p. 18. U. S. G. S. Bull. 540, pp. 73-74.

Florence Claim, see Phillips.

Franklin, see Milkmaid.

Gambrinus (No. 40). One claim of this old mine in Sec. 16, T. 32 N., R. 6 W., is being held by W. E. Saunders of Schilling, who is living on the property. Tunnels and other underground workings are caved, and a few surface cuts are all that can now be examined. The mine was discovered in 1870, and according to Ferguson[1], in 1912, a known production of $127,000 had been made; and some additional production had been made, of which no record had been kept.

Bibl: State Mineralogist's Report XIV, p. 786. U. S. G. S. Bull. 540, pp. 38, 39, 50, 51.

Ganim Gold Mines Company (No. 41), J. S. Ganim of Redding, president, holds a group of 14 unpatented claims in Sec. 5, 8, T. 32 N., R. 6 W., 2½ miles northwest of Schilling. The lowest adit level on this property has been extended to a length of 900 feet, with branches additional as mentioned below. It exposes a body of talc with a maximum width of about 60 feet between two bodies of siliceous material carrying sulphides. Most of the sulphide is pyrite, but there is some chalcopyrite, sphalerite, and possibly a little galena. These bodies of siliceous material have about the same width as the talc, and are stated by Ganim to assay from $1.50 to $2 in gold with an occasional sample as high as $50. The strike is northwest and southeast and the dip 45° to the northeast. A west drift from this main adit is 250 ft. long, and there are two crosscuts from the latter with a total length of 70 ft. Four raises in the talc average 50 ft. each. From a second drift, 110 ft. long, a raise of 140 ft. reaches the surface. There are also a 70-ft. winze and crosscuts of 100 ft. and 30 ft. from this drift. Cuts here and there on the surface along the strike of the talc indicate that it has a possible length of 1000 ft. or more. The last talc shipped was in 1929, 12 to 15 carloads bringing $10 to $10.50 per ton, f.o.b. San Francisco. Freight and hauling costs $4.50 per ton.

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[1] Ferguson, H. G., Gold Lodes of the Weaverville Quadrangle, U. S. G. S. Bull. 540-A, pp. 44–45, 1913.

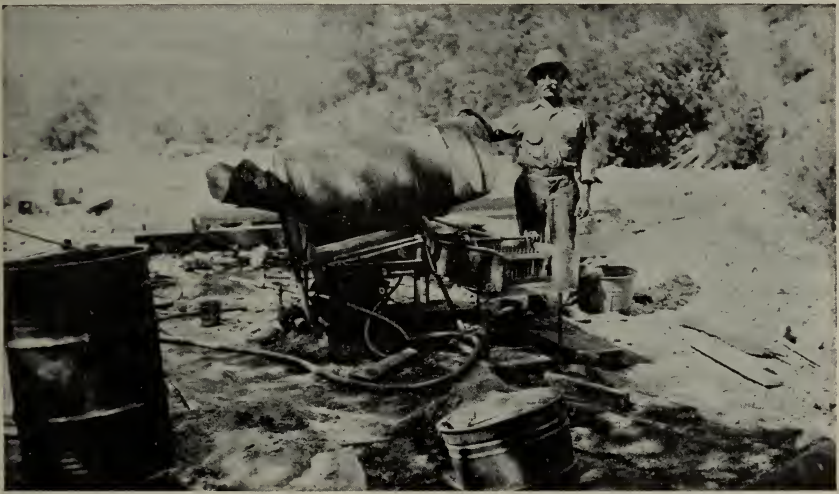

FIG. 4. Kennerly gold saving machine, tried for short time at Ganim mine. (See description No. 41.)

At time of visit, Ganim was working on a quartz vein higher on the hill. It is a vertical vein showing 3 to 4 ft. of white quartz containing various copper minerals, sulphides, carbonates, etc.; and is stated to assay $8 to $10 per ton in gold. The crosscut adit is 100 ft. long, and drifting from it amounts to 100 ft. If the main level is extended 500 or 600 ft., it will cut this vertical vein, giving backs of 435 ft. Equipment consists of Chicago Pneumatic compressor, 9 by 14 inches, 325 cubic ft. per minute, driven by a semi-Diesel 50-hp. engine, drill sharpener, air drills and air hoist.

Bibl: State Mineralogist's Reports XVIII, pp. 730-31; XIX, p. 11; XX, p. 15; XXII, pp. 171-72, 210-11.

Garfield, see Lone Cedar.

Gibson, Molly, see under 'M.'

Gladiator Gold Mining Co. (No. 42) (Hiatt) owns a patented claim, the Cleveland, M. S. 5197, in the NE¼ Sec. 15, T. 32 N., R. 5

W., about five miles by road north of Redding. According to an old map by Albion S. Howe, on file at the Redding office of this division, the mine was developed by a shaft on the vein to the 200-ft. level. On the 100-ft. level, about 250 ft. of drifting was done, and two shoots of ore, each about 100 ft. long were stoped. On the 200-ft. level, only 25 or 30 ft. of drifting was done. The vein varied from a foot to three feet in width, averaging about 14 inches, and the dip was very steep. The collar of the old shaft and the top of a raise, 30 ft. east of it, are both caved at the present time (1932) and are choked with old timber a short distance below the surface. Where the vein is exposed in these openings, it is a stringer zone, with quartz stringers one or two inches in width in andesite. Total width of this stringer zone is given above. There is no equipment of any value.

Gladstone Mine (No. 43) in Sec. 1, 7, 8, 12, 18, T. 33 N., R. 6 & 7 W., 4½ miles northeast of French Gulch is the property of Hazel Gold Mining Co., C. F. Kimball, secretary, 1103 First National Bank Building, San Francisco. This is the deepest mine of the region, and has a production variously estimated at between $3,000,000 and $5,000,000. The vein occurs in the slate, sandstone and conglomerate of the Bragdon formation, in a crushed zone 60 ft. wide. The upper part of the mine to a depth of 1000 ft. was worked through adits, from the lowest of which a shaft was sunk 1400 ft., with levels about 100 ft. apart. The mine has been idle for more than four years, and the lower part is full of water. Considerable equipment, including a 30-stamp mill of 1050-lb. stamps and good buildings, remains on it. Further details may be found in the references given below, of which the April, 1926, chapter of State Mineralogist's Report XXII is available at offices of the Division of Mines at 25c per copy.

Bibl: State Mineralogist's Reports VIII, pp. 568–69; X, p. 637; XI, p. 45; XII, pp. 248–49; XIII, p. 357; XIV, p. 787; XVIII, pp. 43, 96, 256; XIX, p. 11; XXII, pp. 172–73. U. S. G. S. Bull. 540, pp. 35, 37, 46, 57–60.

Globe Mine (No. 44) in Sec. 15, 16, 21, T. 35 N., R. 10 W., four miles north of Dedrick, at an elevation of 6100 to 6700 ft., is an old mine on which a 20-stamp mill and cyanide plant were operated in 1913, and later. It has been idle for a number of years; workings have caved; and equipment has been taken away. Details concerning the old workings will be found in the January, 1926, chapter of State Mineralogist's Report XXII, copies of which are available at offices of the Division of Mines at 25c per copy.

Bibl: State Mineralogist's Reports X, pp. 711–12; XI, p. 483; XII, pp. 309–10; XIII, pp. 432, 442, 447; XIV, pp. 889–91; XVII, p. 540; XXII, pp. 20, 21. U. S. G. S. Bull. 540, pp. 76–78.

Gold Hill Mining Co. see Eiller.

Gold Leaf (No. 45) or Crown Deep is an old property of 122 acres, unpatented, in Sec. 5, T. 31 N., R. 5 W., recently transferred by E. P. Preble to D. F. Densel and W. S. Standish of Los Angeles. A small amount of cleaning out of old workings is all that has been done recently.

Bibl: State Mineralogist's Reports VIII, p. 358; XVII, pp. 521–22; XVIII, pp. 296, 298, 354, 406, 495; XIX, p. 11.

Golinsky Mine (No. 46) in Sec. 28, T. 34 N., R. 5 W., is assessed to Golinsky Copper Co, c/o W. D. Tillotson, Redding; and is leased to H. M. Vickery and W. C. Vickery of Kennett. From the electric substation near Kennett, 2½ miles of steep one-way road follow the old electric railway grade to the Holt and Gregg quarry. From here it is about a mile and a half by trail to the mine, which is located on the steep side of the canyon of Little Backbone Creek. Vickery Bros. leased the mine with the idea of treating the gossan that overlies the copper ores formerly mined here, for gold. A plant using plate-amalgamation was first constructed, but this treatment was not successful, and it was decided to convert it to use the cyanide process, from which good results have been obtained on this type of ore by the Mountain Copper Co., at Iron Mountain. A heavy storm destroyed some of the buildings and cyanide equipment in the winter 1931–32, and the plant has not yet been completed. It was designed to treat 200 tons per day. A sample map of the Golinsky, on file in the Redding office of this division, indicates that the gossan here carries very good values in both gold and silver; but the tonnage is much smaller than that at Iron Mountain.

Bibl: State Mineralogist's Reports XIV, p. 766; XX, p. 432; XXII, p. 149; Bull. 50, p. 100.

Great Western Gold Mines, Ltd. (No. 47), a Washington corporation, is purchasing from H. C. Christensen, Knob Route, Redding, four unpatented mining claims, in Sec. 22, T. 31 N., R. 6 W., in the Muletown district, through A. O. Witte of Seattle. Fiscal agents are Comonett Co., 1411 4th Ave., Seattle. The property is 12 miles southwest of Redding by dirt road.

On this group, a gulch cuts through a vein; and drift-adits have been run both ways from it. The drift to the northeast follows a vein with vertical dip, and width from a few inches to three feet, average say 18 inches, possibly 2 ft. where a small stope has been made. Christensen says that 40 tons of $16 ore were shipped from here to the Keswick smelter years ago. The length of the northeast drift is 350 ft., and two crosscuts have been run near the face to a practically parallel vein, 15 ft. to the northwest, and 50 ft. of drifting has been done on this second vein. It shows a few inches of quartz and a 2-inch streak of nearly solid pyrite in one crosscut. The other drift-adit, running 150 ft. to the southwest, follows the vein for a short distance, and it then pinches down to a width of only a few inches. It has been traced for 500 or 600 ft. farther in this direction by means of surface-cuts and shallow shafts, and is thought by the operators to be the same vein on which a small body of good ore has recently been discovered at the Potosi mine, half a mile to the southwest. Christensen states that at a point 300 ft. southwest of the portals of the two adits he has recently extracted 10 tons of ore that free-milled $11 per ton. Additional values in the sulphides were not saved. The vein is associated with a fine-grained greenish-gray dike rock (probably dacitic) in the quartz diorite.

Machinery from a small mill, erected on this property about 1928, has been removed with the exception of a Size O Gates gyratory crusher, belted to a 3-hp. gasoline engine. At the time of visit, in

July, 1932, Great Western Gold Mines, Ltd., had done no new work on the claims.

Greenhorn Mine (No. 48) comprising 15 patented mining claims and 120 acres of other patented land in Sec. 6, T. 32 N., R. 7 W., 22 miles by State highway northwest of Redding, is assessed to Atascadero Copper Co., c/o Frank H. Proctor, 14th Floor Tribune Tower, Oakland.

Copper ore occurs here as lenticular bodies of heavy sulphide in a shear-zone in altered rhyolite, which strikes N. 60° W., and dips 40° SW. This sulphide ore is chiefly chalcopyrite associated with pyrite and pyrrhotite. The management claims about 250,000 tons of 3% copper ore blocked out. There is also a certain amount of secondary copper ore of very high grade, containing chalcocite, cuprite, native copper, and a little malachite and azurite. When the price of copper was around 18c per pound in 1929 and early 1930, a number of carloads of this ore were shipped to a smelter at Tacoma. The grade was high enough so that a profit was made in spite of the long truck and railroad haul. At the same time development work was done in a body of gossan that overlies these ores, and samples were taken which showed very good values in gold. However, what tonnage of this gossan was developed is not known to the writer. The mine has been idle for about two years, and efforts to obtain further data from the owners have not so far been successful. Albert Hanford, 791 Highland, Piedmont, California, is interested in the company, and was in charge of the last work done there. There are buildings on the property but no machinery.

Bibl: State Mineralogist's Reports XVII, p. 518; XX, p. 433; XXII, p. 149.

Green, Tom, see under 'T.'

Halcyon Mine (No. 49) comprises five unpatented quartz claims, Halcyon, Ruby Pearl, Midway, Globe and Long Pine, in Sec. 17, T. 33 N., R. 7 W., held by C. C. Fox and Wm. C. Blagrave of French Gulch. It is on the steep mountain, adjoining the Washington mine, and the distance from Redding is 25 miles. The Halcyon Syndicate, J. H. Scott, President, Merchants Exchange Building, San Francisco, was operating the property late in 1932. Under the supervision of A. A. Wren of French Gulch, 15 to 18 tons per day of a soft, decomposed surface ore were being put through a 3½-ft. Huntington mill, and treated on amalgamating plates. Operators stated that the recovery by this method was high, and amounted to $8 to $12 per ton. The crew consisted of eight men. Power was furnished by the Pacific Gas and Electric Co.

The ore is a soft, decomposed diorite-porphyry, found near its intrusive contact with the Bragdon slates. The diorite-porphyry contains numerous quartz stringers, an inch and less in width; and the more of these that are present, the better the ore is stated to be. A few larger stringers are found also, stated to contain high-grade ore. The diorite-porphyry is so decomposed that no blasting is necessary in mining it, only picking. Several hundred feet of development work have been done recently at a maximum depth below the surface of 50 or 75 ft., and it is the ore from this work that has been milled.

Bibl: State Mineralogist's Report XIV, p. 789.

Happy Jack (No. 50) is a group of six patented claims in Sec. 28, 33, T. 32 N., R. 6 W., 10 miles west of Redding, recently acquired at a tax sale by H. H. Shuffleton, Jr., of Redding. The property is stated to contain several quartz veins that carry gold, with widths as great as 8 ft., in the reference below. The Mineral Survey number is 3163.

Bibl: State Mineralogist's Report XVII, p. 522.

Harmont Mining Syndicate, see Benson.

Harrison Gulch (No. 51) (Midas, Victor and Twinvict Groups). The location is in Sec. 3, 4, 10, T. 29 N., R. 10 W., in the southwestern corner of Shasta Co., 52 miles from Redding. J. B. Moore of Knob, Shasta Co., is the present owner, having acquired the property at a tax sale. Very extensive mining operations were carried on here for years, but nothing has been done recently; and much of the equipment has been removed. For a description of former operations see April, 1926, chapter of State Mineralogist's Report XXII, pp. 173–74, copies of which are on sale at offices of this division at 25¢ each.

Bibl: State Mineralogist's Reports XIV, p. 792; XXII, pp. 173–74; Pre. Rep. No. 8, p. 18.

Hiatt, see Gladiator.

Hoboe (No. 52) is an unpatented claim in Sec. 17, T. 33 N., R. 7 W,. in the French Gulch District, near the Washington and Niagara mines. It is held by Ernest Blagrave of French Gulch, who has made some recent production from a 2-ft. quartz vein with a vertical dip. A lower crosscut adit was being driven to tap this in July, 1932. The ore is treated in a 2-stamp mill owned by Blagrave and located near the Niagara mill. Small lots of custom ore from other parts of the district are crushed here also. The only treatment is amalgamation.

Houston, Sam, see under 'S'.

Independence (No. 53) is a group of seven claims in Sec. 4, 32, T. 29 & 30 N., R. 10 W., in the Harrison Gulch district, held by John Kutz of Knob. The owner states that a number of quartz veins have been developed by different workings on the group with widths as great as 6 ft., and good values in gold. Two hundred tons have been milled. This property was not visited during the present survey, due to lack of time.

Iron Mountain, see Mountain Copper Co.

Isabel and Queen (No. 54) are two unpatented claims in Sec. 8, T. 32 N., R. 6 W., in the Whiskytown district, held by F. C. Darrow of Schilling. He is prospecting these alone, and has two open cuts about 10 ft. deep on either side of a small gulch. They expose a shear-zone in greenstone, striking S. 60° E., and with a steep dip to the northeast. The width is about 10 ft. There are a few quartz stringers from a fraction of an inch to an inch wide in this shear-zone, and the mixture of this with the country rock (Copley meta-andesite) pans a little free gold. Darrow states that he recently took out a $40-pocket about 200 ft. away, but not on this same shear-zone. Several hundred feet of old tunnels are open on another part of the claims, and quartz showing plentiful chalcopyrite is piled on the dump. This quartz is stated to have come from an old winze, now full of water.

Jensen Group (No. 55) is in the Centerville District, in Sec. 24, T. 31 N., R. 6 W., and adjoining sections, and is held by Geo. P. W. Jensen, 320 Market St., San Francisco. The group is now leased to H. C. Christensen, Knob Route, Redding, who states that Geo. Morrison and Wm. Hague produced $2400 here a year ago, from a 125-ft. incline now full of water. Small seams of gouge carrying lenses of pyrite a few inches wide are seen in prospect cuts.

Jim Fisk (No. 56) Santa Claus and Orifice are three patented quartz claims in the Muletown District, Sec. 15, T. 31 N., R. 6 W., assessed to Mrs. Frances Klapetsky of Long Beach, California. In the reference given below is described a mill of odd design of 2½ tons capacity in 24 hours, which was operated here for a short time about 1893. All that can be seen now are a few caved, shallow shafts and open cuts on a quartz vein, 2 ft. wide, that follows a dike (probably rhyolitic) in quartz diorite. No mining has been done here recently.

Bibl: State Mineralogist's Report XII, p. 251.

Jones Property (No. 57) is in Sec. 19, T. 32 N., R. 5 W., at the old smelter town of Keswick, six miles by road from Redding. It comprises 44 acres of patented land bought from the railroad and one unpatented mining claim, held by E. F. Jones and Rosa Jones, Box 371, Redding. The old Black Spider mine is included.

Quartz veins from a few inches to 2½ ft. in width, occasionally 4 ft., are found here, associated with dikes in the quartz diorite. The general appearance of these dikes is that of a fine-grained basic rock, but in one place an acidic appearance was noted, possibly due to secondary silicification. Jones states that the bunches of high-grade ore found here have been at the intersections of the quartz veins and the dikes, and that the largest of these bunches removed by him produced $1200 from a few tons of ore.

In 1931, P. T. Atwood and A. C. Most did some work on the property. A shaft was sunk 80 ft. and 40 ft. of drifting was done near the bottom. Water now stands in the shaft to within 35 ft. of the surface. An adit, which penetrated some of the old workings, was opened up for a distance of 120 ft., requiring spiling and heavy timbering. Besides the hoisting machinery, a very light stamp mill, depending on springs to add force to the drop of the stamps, was installed. All of this machinery has since been removed, and Jones is working the property alone.

Bibl: (Black Spider) State Mineralogist's Report XII, p. 246; XIII, p. 350; XIV, p. 779.

Jumbo Prospect (No. 58) comprises 40 acres of patented land in Sec. 18, T. 31 N., R. 5 W., six miles southwest of Redding. It was formerly worked for placer gold, and shows a bedrock of Copley meta-andesite intruded by dikes of quartz diorite; also quite a few quartz stringers. The owners, Ira Smith and others of Redding, think that the whole mass contains enough gold to make mining on a large scale profitable. Whether this is true, or whether the gold is confined to the quartz stringers and fractures in the bedrock into which fine particles of placer gold have found their way, can be determined only by development work. Old superficial development work consisting of open cuts and shallow shafts has caved.

Bibl: State Mineralogist's Report XVII, p. 522.

Kanaka Prospect (No. 59) (Sunshine) is a group of four unpatented claims in Sec. 28, T. 32 N., R. 6 W., nine miles by road west of Redding, held by John R. Kemble of Schilling. Quartz veins, carrying gold in pyrite and chalcopyrite, are found associated with the intrusive contact of the quartz diorite into Copley meta-andesite. On the Dorothy claim is a crosscut adit, 80 ft. long, from which 200 ft. of drifting has been done on the vein. At time of visit, about half of this drifting was not accessible on account of caving. Average width of the vein is 14 inches, maximum 5 ft. The strike is east and west, and the dip 60°. At the intersection of the crosscut adit with the drifts is a winze full of water, depth unknown. Several parallel veins are known, and, judging from dumps, there are several hundred feet of workings on these, now caved. A white quartz vein with an average width of 4 ft. and a maximum of 10 ft. outcrops for a distance of 500 ft. on the K. N. H. and Bullfrog claims; but there is no development work on it. A small Huntington mill was placed on this property in 1928–1929, but it was later removed; and no production resulted.

La Clair Prospect (No. 60) comprises 20 acres of patented land bought from the railroad, and assessed to L. E. Van Ness, 4920 Park Boulevard, Oakland; also two unpatented mining claims held by Robert Mack of French Gulch. The patented land is in Sec. 13, T. 35 N., R. 8 W., and the claims in the adjoining Sec. 24. The distance from Redding is 42 miles, 18 miles state highway to Tower House, 23 miles dirt road to confluence of Van Ness Creek and Trinity River, boat across river, and one mile steep trail to the claims, 1000 ft. above river level. They are just across the river from the mouth of Van Ness Creek, on which the Five Pines mine is located. A flat incline shaft follows the slate-andesite contact down for 60 ft. The strike is east and west and the dip 20° north. Drifts near the bottom of the incline expose the contact for 12 ft. in one direction and 14 ft. in the other. At the bottom, a 12-ft. raise from a 350-ft. adit level below connects with the incline. On the contact are bunches and lenses of quartz about 14 inches in width that pan free gold. Mack estimates the value at $12 to $15 per ton. On the 350-ft. adit level is another drift on the contact, 25 ft. long, showing irregular bunches of quartz. Of the 350 ft., total length of this main level, 50 ft. near the face is drifting on a second vein entirely in the black slate. It shows 4 to 5 ft. of mixed quartz and black slate, which Mack states assays $2.50 per ton in gold. A 10-ft. raise from the adit level exposes this vein, with a dip of 45° to the west. The property was idle in the summer of 1932, but assessment on the unpatented claims was to be done later.

Lappin, see Calmich.

Lila (No. 61) is a claim in the Deadwood District just above the Brown Bear Mine, assessed to T. E. Thurner and Gruss estate, 1130 Chestnut St., Chico. It is in Sec. 12, T. 33 N., R. 8 W. J. B. Grigsby, address Lila Mine, via French Gulch, is working the property on lease and option. At time of visit two men were moving thirty tons of sacked ore extracted in former operations so that it could be loaded on trucks and hauled to the small stamp mill on the Lappin or Calmich property. Prospecting was to be done later in the old workings consisting of several hundred feet of tunnels with some stoping on quartz fissure veins carrying free gold and pyrite. Country rock is typical of French Gulch and Deadwood districts, Bragdon slates intruded by porphyry dikes. Veins observed in the workings are steeply dipping fissures in the hard dioritic porphyry.

Little Alice, see R. A. M.

Lone Cedar Prospect (No. 62) (Garfield) comprises two unpatented claims in Sec. 34, T. 33 N., R. 5 W., ten miles north of Redding, held by Wm. Goll, Buckeye Route, Redding. The last mile is trail at present, but an old road could be graded out to the portal of the working tunnel at small expense. A surface cut exposes a quartz vein with a width of 14 to 18 in., showing oxide of iron and some spots of chalcopyrite. At time of visit in the spring of 1932, Goll was cleaning out the portal of an old tunnel below, which he thinks is 140 ft. long, and in which he states that the vein is exposed with a width of 3½ ft. A hundred feet or more lower in elevation is a crosscut adit, several hundred feet in length, which is caved at the portal. It probably has not yet reached the vein. Equipment consists of car and track. Country rock is a rhyolitic dike intruded into Copley meta-andesite. The northern properties of the Old Diggings District are just to the west on the other side of a low ridge.

Bibl: State Mineralogist's Report XIV, p. 787.

Los Andes Gold Mining Co. According to C. E. Bass of Tacoma, a company of this name is to take over the Clipper and Snyder mines, (which see) equip and operate them immediately. It is a Nevada corporation.

Lucky Boy Prospect (No. 63) is a group of seven unpatented mining claims in Sec. 15, T. 33 N., R. 5 W., held by Dr. H. C. Erno of Redding, and Clay Vance of Portland. It is two miles south of Kennett by a rough road, and is practically on the Sacramento River, only the right-of-way of the Southern Pacific being between the property and the river. Part of it was formerly called the Red Cut, named from a red bank facing the river.

Numerous quartz stringers from an inch to a few inches in width, and with various strikes and dips are found in the alaskite porphyry here. Some 20 pockets are said to have been mined from these stringers by means of shallow cuts and shafts, with a total gross production of $20,000. At time of visit, in April, 1932, one man was employed, drifting on a 4-inch quartz stringer in the face of a 200-ft. adit. Present owners are holding the property with the idea of trying to develop a large body of low-grade ore that can be mined with power shovels.

Three samples taken by Alex M. Wilson of Oroville are stated to have given gold assays from $1.25 to $4 per ton.

Lyons Mine (No. 64) is a group of four fractional patented quartz claims 48 acres in Sec. 22, T. 33 N., R. 5 W., adjoining the National. It is the property of James P. Bradner and others, 977 Mission St., San Francisco. Some stoping was done here on a quartz vein, and the ore was removed through an adit-level, years ago.

Mad Dog Prospect (No. 65) includes three unpatented claims held by L. E. Alpaugh and C. A. Williams of Redding in Sec. 10, T. 32 N., R. 6 W., 18 miles northwest of Redding. The last three quarters of a mile is steep mountain trail. A sheer zone about 45 ft. wide is found in a fine-grained silicified alaskite, and in this zone are quartz veins from a few inches to 3 ft. in width, average say one foot. This quartz pans a little very finely divided free gold. Development consists of one 146 ft. adit level, which was driven by means of picking only, as blasting is likely to start a cave. According to Alpaugh, some good gold assays were obtained from grab samples taken from the broken material removed in driving the tunnel.

Maddox Mining Co. (No. 66) (Mad Ox) (Caribou Gold Mining & Power Co.). This mine is in Sec. 28, T. 33 N., R. 6 W., and is assessed to Maddox Mining Co., c/o Grace Schilling, Redding. Three claims were purchased by the company, and additional mining claims have been located. W. H. Grant, Box 64, Palo Alto, is president, and E. E. Erich of French Gulch is engineer. By road, the mine is 16 miles northwest of Redding, 11 miles state highway, balance mountain road. It was idle when visited, and underground workings were not entered. The following description of these was furnished by W. H. Reel of Schilling, who owned an interest in the property. He states that total work on the main adit level amounts to 2000 ft., 900 ft. of cross-cutting and 1100 ft. of drifting, and that two shoots of ore are exposed, each 60 ft. long and 2 to 4 ft. in width. These are 100 ft. apart. At a distance of 600 ft. is a shoot of lower grade, 50 ft. long, maximum width 20 ft., value $6 to $8 per ton. A winze, 135 ft. deep, from this level was full of water. Reel says that there is 100 ft. of drifting from the bottom of this, showing a 6-ft. vein but no pay shoot, and that on the 90-ft. level is a drift 135 ft. long.

Equipment includes an Ingersoll portable type compressor with a capacity of two drills, driven by gasoline engine; also Leyner drill-sharpener, 10-stamp mill of 850-lb. stamps, jaw crusher and amalgamating plates.

Bibl: U. S. G. S. Bull, 540-A, p. 45.

Mad Mule Mine (No. 67) (Banghart) is a patented property of 43 acres in Sec. 31, T. 33 N., R. 6 W., five miles due north of Whiskytown by mountain road. Whiskytown (Schilling P. O.) is on the Redding-Weaverville highway. The holding, Lot 37, has been divided into separate parcels, one assessed to Geo. Jackson, R. 1, Box 169, Los Gatos, the other to J. W. Curry and others, 589—31st Street, Oakland. M. T. Thomsen, 1835 Santa Clara Ave., Alameda, is stated to have an interest in the latter parcel. The mine is a typical pocket mine, free gold being found in small shoots, but at times in single pieces worth several thousand dollars each. It is associated with an intrusive dike of striking appearance, containing feldspar crystals, a half inch long, in a fine-grained gray groundmass, in which are minute hornblende needles. The dike cuts the meta-andesite, the alaskite, and the conglomerate and slate of the Bragdon formation; and its width is about 150 ft. The free gold is usually found in the slate at its contact with the dike, and at 'points,' where there is a sharp change in direction, like the crest of a fold, the bottom of a trough, or an intersection with a fault-plane. According to W. H. Reel of Schilling, who has recently been leasing here, workings amounting to about 8 miles of drifting and raising on the contact have been driven in the search for such pockets. Total production is roughly estimated at over $1,000,000.

Bibl: State Mineralogist's Reports IX, p. 38; XI, p. 397; XII, p. 252; XIII, p. 361; XIV, p. 791; XIX, p. 11; XXII, p. 175. U. S. G. S. Bull. 540, pp. 40, 42, 52–54.

Mammoth, see old Diggings; also U. S. Smelting, Refining and Min. Exp. Co.

Mason and Thayer (No. 68) (Craig) is a property of 17 claims in Sec. 33 (approx.) T. 35 N., R. 10 W. The survey to subdivide this area into sections has not yet been made. J. B. and F. J. McCauley, 524 Gough St., San Francisco, are the owners. From Redding, it is 75 miles to the northwest, 60 miles State highway through Weaverville, balance mountain road, steep, narrow, and winding, the last mile being for tractor only. Quartz veins carrying gold and sulphides are found in hornblende schist; and dioritic dikes, six to 60 ft. wide are associated with them. Workings consist of a mill-tunnel level of a total length of 2000 ft., 1200 ft. of which is drifting. On a level 70 ft. higher is 260 ft. of drifting, and there are two raises between these levels. On a level 60 ft. still higher is 260 ft. of drifting and a raise to the surface. According to Keith MacKay, superintendent, this work blocks out 9000 to 10,000 tons of $6 ore in a shoot 170 ft. long and with a width of 3 ft. Strike is N. 70° E., and dip 45° S. In a tunnel below the mill-tunnel level, 350 ft. of drifting has recently been done on a body of base ore that assays $3 to $5 per ton.

Equipment includes numerous buildings, a new 100-hp. hydro-electric plant on Canyon Creek, 173-cu. ft. Chicago Pneumatic compressor with 45-hp. Hercules gasoline engine, drill sharpener, 22-hp. Cletrac tractor, and a sawmill of 5000 board feet capacity in 8 hours. There is also a 5-stamp mill, 6 by 5 ft. ball mill, crusher 14 by 12 inches, two flotation machines, two Deveraux agitators, concentrating tables, and electric motors. Only a few hundred tons of ore have been milled with this equipment, and it was idle at time of visit. Six men were employed on development work.

Bibl: State Mineralogist's Reports XIV, p. 887; XXII, p. 16. U. S. G. S. Bull. 540, p. 78.

Meeks Property (No. 69) consists of patented land in the SE¼ of the NE¼ of Sec. 15, T. 32 N., R. 5 W., about five miles by road north of Redding. A small quartz vein was developed some years ago by means of a vertical shaft. The collar of the shaft is now caved. An old five-stamp mill stands on the property. The vein is in the contact zone between the alaskite and the Copley meta-andesite.

Menzel Mine (No. 70) comprising the Scottish Chief and Santa Clara patented claims, in Sec. 31, T. 33 N., R. 5 W., in the Flat Creek Mining District, is owned by Wm. Menzel of Redding. Old workings on the surface, consisting of cuts, tunnels and an 80-ft. shaft, have caved. Some production was made from these about 1880 or 1890. By means of outcrops and these old workings, the vein can be traced for at least 1000 ft. on the surface. Widths vary from a fracture containing no quartz to a maximum of 6 ft. of quartz, with some country rock between strands of the vein. The strike is S. 85° W., and the dip 60° or 70° to the south. A fine-grained, basic, pre-mineral dike, one or 2 ft. wide, accompanies the vein.

A main tunnel level, roughly 150 ft. below the outcrop, crosscuts in the hanging wall of the vein for 600 ft., then turns and follows the vein to the west for 200 ft. The width varies from nothing to a maximum of 8 ft. of quartz at the face. This face is stated to sample $4 to $5 per ton in gold. Near it is a raise, and 35 ft. above is an intermediate level with 140 ft. of drifting to the west and 25 ft to the east. The width here varies from nothing to 6 ft., with an average of 3 ft. Above this intermediate, at the raise, a stope has been carried up 30 ft. high and 30 ft. long, and a raise from the west end of this has tapped some of the old caved workings at a height of 20 ft. above the face of the stope. Chas. Hammond, who has recently cleaned out all of these old workings and has done some additional raising, removed 30 tons of sorted ore from the east end of this stope, which he states returned $18 per ton by amalgamation. Ore in the face of the stope is a white ribbon quartz, and a little chalcopyrite was seen in it. According to a report on file in the Redding office of this division, written by J. E. Miller, the vein continues into the adjoining Murrey claim of The Mountain Copper Co. Hammond's equipment, consisting of 3½-ft. Huntington mill and amalgamating plates has since been removed. He ground the ore to pass a 40-mesh screen.

Bibl: State Mineralogist's Report XIV, p. 797.

Midas, see Harrison Gulch.

Milkmaid and Franklin Mines (No. 71) have been idle for a number of years, and have not been visited by the writer. A description of them will be found in the April, 1926, chapter of State Mineralogist's Report XXII, pp. 175–76, copies of which are available at offices of this division at 25¢ each. There is also a bibliography in the same report p. 183.

Minnesota Mine (No. 72) includes 34 acres patented, M. S. 3585, and one unpatented claim in Sec. 1, 2, T. 32 N., R. 6 W., owned by Stephen Girard of Redding. It is 13 miles by road northwest of Redding, the last mile of which is not in good condition. According to Girard, the property was worked 40 years ago by Joe and Oliver Longfield, and the Minnesota Company bought it in 1891 or 1892. An arrastre, driven by water power from Spring Creek, was used in the earliest work, and later a 10-stamp mill was run for three months. Girard worked in the lowest adit level at the 900-ft. point years ago, and thinks that the total length is 1200 ft. At time of visit, he was cleaning it out and retimbering at the 500-ft. point. The level starts in a shearzone in a dike, probably alaskite, and follows this for 300 ft., at which point quartz starts to come in; and it widens to 4½ ft. at the 500-ft. point. Beyond this is a caved stope, which appears to have been 7 ft. wide. The ore is quartz carrying pyrite and chalcopyrite, with a strike of N. 75° to 80° W., and dip 70° N. The general formation is quartz diorite, intruded by dikes. On the unpatented claim, at a point 1300 ft. to the west of workings just described, a tunnel 350 ft. long, of which 250 ft. is open, follows an 18-inch quartz vein. The strike and dip are the same as those in the main working tunnel, and the vein may be the same one.

Bibl: State Mineralogist's Reports X, p. 635; XII, p. 255; XIII, p. 363; XIV, p. 794.

Molly Gibson (No. 73) is a group of seven claims in the Harrison Gulch District, Sec. 4, 5, T. 29 N., R. 10 W., held by John Kutz of Knob. According to the owner, there are nine veins on this group, opened by means of over 1000 ft. of tunnels. It was not visited during the present survey due to lack of time.

Mount Shasta Mine (No. 74) including one patented claim and two unpatented claims, total 52 acres, in Sec. 34, T. 32 N., R. 6 W., 10 miles west of Redding, is owned by H. H. Shuffleton of Redding. The Monitor and Lucky Boy of 20 acres each were surveyed for patent under M. S. 3582, but the patent was not completed. The deposit consists of two parallel veins, 50 ft. apart, of white quartz carrying pyrite and gold, in a dike of sheared alaskite porphyry in the quartz diorite. The main vein is 5 ft. wide and the parallel vein 4 ft. There is a recorded production of $178,000 from smelter shipments, and some additional production was made with a stamp mill that stood on the property; but there is no record of this.

Work on the seventh level, 465 ft. below the collar of the shaft, consisted of 140 ft. of drifting to the north on the west, or main vein, to a fault, and a little drifting was done on the east vein. Later H. O. Cummins sank the shaft 193 ft. deeper, cut a station, and started a crosscut, but quit late in 1913. After January, 1914, a watchman was kept on the property for several years. Surface improvements have since burned, and the mine is full of water. The owner has reports on the mine by H. O. Cummins and Guy M. Vail.

Bibl: State Mineralogist's Report XIV, p. 794. U. S. G. S. Bull. 540, pp. 39, 44, 46, 47–48.

Mountain Copper Co., Ltd., The (No. 75) Sec. 34, 35, T. 33 N., R. 6 W. Complete technical details of the cyanide treatment of gossan by this company in a 550-ton plant were given in the April, 1931, chapter of State Mineralogist's Report XXVII, pp. 129–38, when a good profit was being made from the operation. Since that time, the extraction has been improved, the grade of the ore has been raised, and additional ore reserves have been blocked out. Hence the operation is very successful. An additional leaching tank has been added to increase the daily capacity also.

Other operations of this company, production of pyrite at the rate of 500 tons per day, and the flotation of siliceous copper ores, have been described in State Mineralogist's Report XXII, pp. 154–160. During the time of high prices of copper, in 1929 and early 1930, the flotation

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Work on the seventh level, 465 ft. below the collar of the shaft, consisted of 140 ft. of drifting to the north on the west, or main vein, to a fault, and a little drifting was done on the east vein. Later H. O. Cummins sank the shaft 193 ft. deeper, cut a station, and started a crosscut, but quit late in 1913. After January, 1914, a watchman was kept on the property for several years. Surface improvements have since burned, and the mine is full of water. The owner has reports on the mine by H. O. Cummins and Guy M. Vail.

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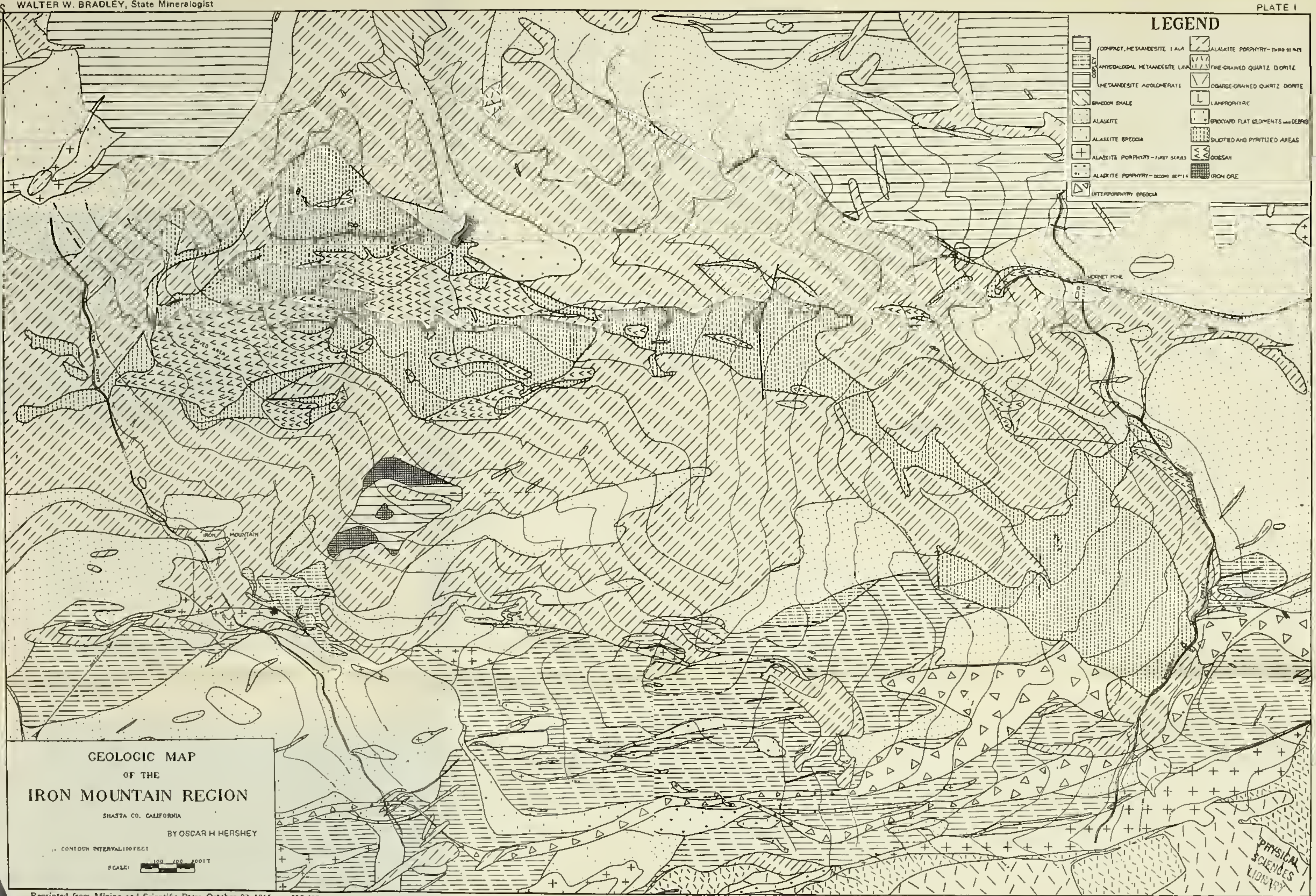
WALTER W. BRADLEY, State Mineralogist

PLATE I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ALASKITE PORPHYRY—SECOND SERIES
INTERPORPHYRY BRECCIA
ALASKITE PORPHYRY—THIRD SERIES
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COARSE-GRAINED QUARTZ DIORITE
LAMPROPHYRE
BRICKYARD FLAT SEDIMENTS AND DEBRIS
SILICIFIED AND PYRITIZED AREAS
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IRON MOUNTAIN
HORNET MINE
CONTOUR INTERVAL 100 FEET
SCALE:
100 400 800 FT

GEOLOGIC MAP
OF THE
IRON MOUNTAIN REGION
SHASTA CO. CALIFORNIA

BY OSCAR H HERSHEY

Reprinted from Mining and Scientific Press, October 23, 1915, pp. 636-637.

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plant was moved to the Iron Mountain No. 8 mine, and remodeled. Flotation concentrates were produced and were shipped to Tacoma for smelting. Copies of the chapters of reports cited are available at offices of this division at 25 cents per copy; hence no attempt has been made to describe details in the present report.

Bibl: State Mineralogist's Reports XIV, 769–70; XX, 440–45; XXII, pp. 154–60; XXVII, pp. 129–38. Bull. 50, pp. 70–78.

Mountain Queen (No. 76) is a group of six unpatented claims in Sec. 30, T. 32 N., R. 5 W., half a mile east of the old town of Shasta, which is six miles west of Redding by State highway. P. G. Parry of Shasta is the owner. He has recently sunk a 50-ft. shaft on a quartz vein 4 ft. to 8 ft. wide, and drifted both ways from the bottom for a total distance of 50 ft. In the faces of these drifts the vein is 4 ft. wide. The strike is S. 65° E., and the dip nearly vertical. The work was done with the idea of exposing the intersection with a second, but smaller, vein which strikes S. 70° W., and has a nearly vertical dip. At a distance of 200 ft. west of the vein first mentioned, is a shaft on the smaller vein, 30 ft. deep. This second vein varies from a few inches in width at the surface to 2 ft. at the bottom. Parry has found his best ore here, but he says that a good shoot was found on the surface by former owners of the claims at the intersection of the two veins. He expects to cut this intersection with 20 or 30 ft. more of drifting from the 50-ft. shaft. The small vein is said to mill $30 per ton in free gold, and a sample cut across the larger vein is stated to have given an assay of $13.14 in gold. One hundred tons of ore are broken, ready for milling. A few tons were recently milled in a small stamp mill of 50-lb. stamps attached to springs, but this was found unsatisfactory; and the mill has been removed.

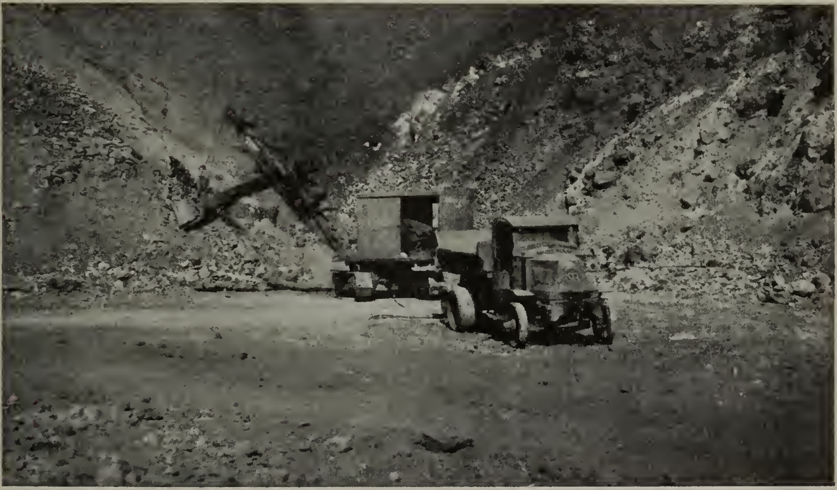

FIG. 5. Gossan quarry, Mountain Copper Company. (See description No. 75.)

Surface cuts indicate that the veins extend for considerable distances beyond present workings, but other veins are probably present; and additional development work is needed to prove continuity. Country rock is quartz-diorite. One wall of one of the veins is a fine grained, dark grayish green dike rock. C. S. Laughton is leasing six acres on the northwestern end of this property, and some additional adjoining ground.

National Mine (No. 77) (Veteran Mine or Forbes Mine) is a group of seven unpatented claims in Sec. 23, T. 33 N., R. 5 W., 10 miles north of Redding, held by G. M. Sleezer of Redding. It is an old group originally located about 1869, and at one time a 10-stamp mill was operated; but this has been removed. Later shipments were made to smelters, and total production is said to have amounted to $200,000. A 1200-ft. adit level and 700-ft. winze from it have been inaccessible for 20 or 25 years.

Recently C. E. Crowell, a lessee, opened up some ore near the surface at a point which Sleezer thinks is farther north than any of the old workings. A shaft was put down 40 ft. on a vein averaging 2½ ft, in width, then a total of 10 ft. of drifting was done on both sides of the shaft at the 25-ft. point, and the lower part of the shaft was filled. The ore is white quartz containing rather abundant pyrite.

At a distance of 200 ft. from the shaft is a 50-ft. drift adit on a 1-ft. quartz vein, from the outcrop of which Sleezer says he shipped 48 tons of $20- to $24-ore to smelters years ago. A similar vein is exposed in an assessment cut about 1000 ft. distant, near the portal of the old 1200-ft. adit. On another claim, the Veteran, there is some 250 ft. of work, 75 ft. of which is drifting on a 2-ft. quartz vein. There are some upper workings on this same vein also. At the portal of the lower tunnel are a compressor and 25-hp. gasoline engine, which have not been used recently.

Niagara Summit Mining Co. (No. 78), c/o W. D. Tillotson, Redding, owns a large acreage of patented mining claims and other patented land in Secs. 6, 7, 8, 17, 18, T. 33 N., R. 7 W., in the French Gulch District. L. W. Bunge of Los Angeles is president of the company.

A large amount of work has been done on these holdings, most of it on the Yosemite claim, and past production is estimated in the references given below at somewhere around $1,000,000. In an upper level called the O'Neil tunnel, which runs northwesterly through the center of the Yosemite claim, a small segment of the Niagara vein was found about 200 ft. southwest of the center of the claim. The Barnes tunnel starts at creek level, cuts through the northeast corner of the Yosemite, and runs southwest through the claim. A little ore was found in the southwestern part. The tunnel continues into the north part of the Comet claim. A recent proposal has called for running to the north at just about the center of the Yosemite claim at a point 2300 ft. from the portal of the Barnes tunnel, in a search for the Niagara vein at this lower level. J. H. Porter of French Gulch has maps of these workings. Equipment includes a 4 to 5-drill compressor of 75 hp., and a 10-stamp mill equipped with crusher, vanners, etc. Work has not yet been started on the project mentioned.

Late in 1931, James Blagrave and son of French Gulch held a lease on one claim of this group, and were mining surface material consisting of oxidized, decomposed diorite porphyry, which formed a layer of sub-soil, a few feet thick, and a few feet below the surface of the ground. The value was stated to be $5 per ton in gold. It was sledded

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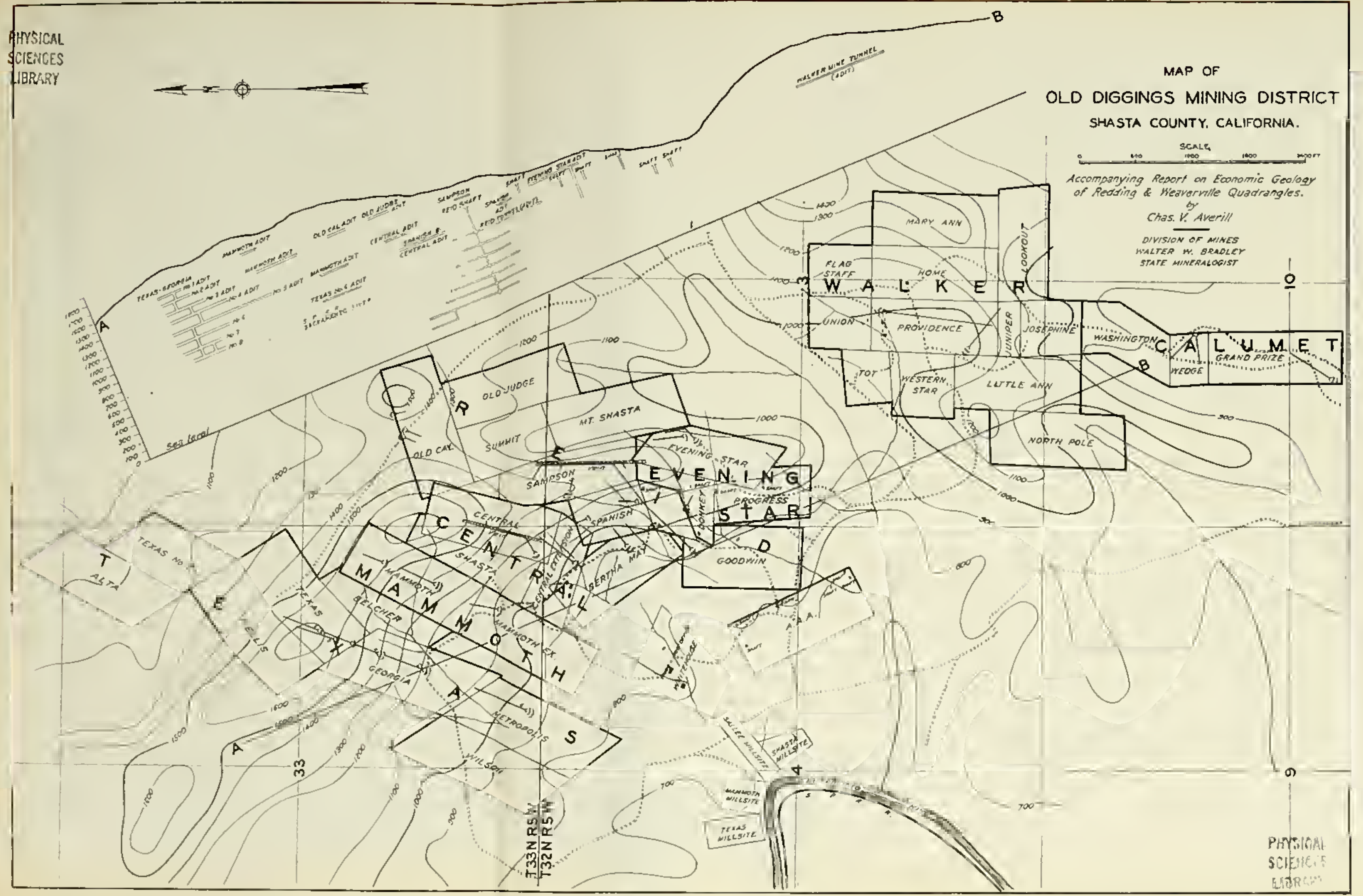

MAP OF
OLD DIGGINGS MINING DISTRICT
SHASTA COUNTY, CALIFORNIA.

SCALE

Accompanying Report on Economic Geology of Redding & Weaverville Quadrangles.
by
Chas. V. Averill

DIVISION OF MINES
WALTER W. BRADLEY
STATE MINERALOGIST

A
B
Sea level
WALKER MINE TUNNEL (ADIT)
TEXAS-GEORGIA No. 1 ADIT
No. 2 ADIT
No. 3 ADIT
No. 4 ADIT
No. 5 ADIT
MAMMOTH ADIT
OLD CAL ADIT
OLD JUDGE ADIT
CENTRAL ADIT
SPANISH & CENTRAL ADIT
TEXAS No. 6 ADIT
SAMPSON REID SHAFT
EVENING STAR ADIT
SHAFT
WALKER
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to a 'Cannon-ball mill,' capacity of 6 tons in 24 hours, driven by an automobile engine. Treatment was by amalgamation.

Bibl: State Mineralogist's Reports X, pp. 636–37; XI, p. 50; XII, p. 253; XIII, p. 363; XIV, p. 793; XVIII, pp. 43, 296; XX, p. 15. U. S. G. S. Bull. 540, pp. 35, 37, 44, 67.

North Star (No. 79) and *Elkhorn* are two patented claims, 34 acres, in Sec. 15, T. 31 N., R. 6 W., adjoining the Potosi mine in the Muletown District. They are assessed to C. W. George of Redding. The Potosi vein, on which some good gold ore has recently been found, appears to run through the North Star. It is developed by means of two shafts, but these are not now accessible. The Spring Gulch Mining Co., which is now operating the Potosi, is reported to have recently optioned the North Star also.

North Star and *Virginia claims* (No. 80), 40 acres in Sec. 8, 9, T. 33 N., R. 7 W., held by Geo. W. Garwood of French Gulch, are optioned to E. L. Waight of San Francisco. A quartz vein averaging about a foot in width, with a steep dip, is found in a dioritic dike intrusive into Bragdon slate. Upper workings consist of a 30-ft. crosscut to the vein and 300 ft. of additional workings of which 90 ft. is drifting on the vein. There is a small stope, 20 ft. high and 20 ft. long. The vein is entirely within the dike. Roughly 70 ft. lower in elevation is the present working tunnel, 320 ft. long, mostly in the slate. It is now (winter, 1932) being driven east on a 2-inch quartz stringer to develop the junction of this with the vein found on the upper level. At time of visit, two men were working with hand tools. Garwood states that the vein is the same as one found in the old Franklin mine adjoining.

Bibl: State Mineralogist's Report XVII, p. 523.

Old Diggings District (No. 81) see accompanying map of the district. See also: Reid, Central, Texas, Evening Star, Walker, Calumet. This old district, producer of several million dollars in gold-quartz ores, is located in Sec. 33, 34, T. 33 N., R. 5 W. and Sec. 3, 4, T. 32 N., R. 5 W., 10 miles north of Redding. Mills using amalgamation were operated here at one time, but later there was a demand for the siliceous ores as flux in the copper smelters; and this outlet proved more satisfactory. Hence the old mills were removed. A few years ago, the last of the smelters in the district shut down also, and these mines were left without an outlet for their ores, with the result that they have all since been idle.

The accompanying map indicates an interesting possibility in the way of grouping these old mines into a single large property with a central treatment plant, if sufficient new ore can be blocked out to justify its construction. Engineers who have investigated the records of some of these old mines have looked with disfavor on the declining value of the ores in the later operations. However, Logan[8] states that the quartz was worth $2 per ton as flux alone. Hence there was an incentive in the later operations to mine the lowest grades of quartz on a large-tonnage basis, rather than to do the development work necessary to block out ore of a better grade. As a result of this, the records show that the last ore mined was low in grade. However, it seems probable that if the future development work is designed to locate pay-shoots, the grade of ore can be kept higher.

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[8] Logan, C. A., State Mineralogist's Report XXII, pp. 168 and 171, 1926.

The district is very accessible, being just across the Sacramento River from the main line of the Southern Pacific Railroad, and only about half a mile distant. It is easily reached by means of 10 miles of road from Redding also.

Old Spanish (No. 82), formerly Deakin and Taylor, is a patented property of 160 acres in Sec. 31, T. 32 N., R. 5 W., four and a half miles west of Redding, held by Ralph P. Newcomb of Berkeley. A five-year lease with option has recently been taken by T. J. Burke of Redding, who states that quartz veins carrying good values in gold are found on the property with widths of one to four feet. Workings amounting to several hundred feet were made here years ago, and shipments of ore were sent to the Keswick smelter. These workings have all caved, and early in 1932, Burke had started to clean out some of them. Some free-milling ore was found at the surface, but the sulphides come in at a depth of only about 10 feet. The veins are associated with the intrusive contact of the quartz diorite into the meta-andesite.

Bibl: State Mineralogist's Reports XII, pp. 246–47; XIII, p. 353; XIV, p. 796.

Oro Fino (No. 83) is a property of two patented claims, M. S. 5343, and one unpatented claim in Sec. 34, 35, T. 32 N., R. 6 W., 10 miles west of Redding, via Shasta, held by Mrs. Edna Behrens Eaton of Redding. Dumps indicate that several hundred feet of work, perhaps a thousand feet or more, were done here. Parts of the dumps are quartz, apparently set aside as a second grade of ore. Caving on the surface indicates that stopes were driven from some of the drifts. Remnants of the veins that can be seen indicate a width of about a foot of mineralized quartz. To the north of these old workings is an outcrop of quartz 8 or 10 ft. wide, on which apparently the only work is a surface cut, 2 ft. deep. The outcrop can be traced for about 100 ft., but the width is not maintained for this distance. Workings are practically all closed by caving; and buildings have burned. Mrs. Eaton has reports on smelter-shipments to The Mountain Copper Co. on some 20 lots, which show gold values of $4.40 to $70.40 per ton. Silver averaged about one ounce per ton. Where the tonnage is given, it seems to have been about 10 tons per lot. Most of the shipments ran $20 and $30 per ton.

The geology is similar to that of the adjoining Mt. Shasta mine, which is described by Ferguson.[9] The country rock is quartz diorite with masses, perhaps dikes, of rhyolite. The latter is very fine in grain, and is flowbanded.

Bibl: State Mineralogist's Reports XI, p. 44; XIV, p. 796.

Oro Grande (No. 84) is a group of six unpatented claims, 100 acres, in Sec. 5, T. 31 N., R. 5 W., four miles west of Redding, recently held by Lewis B. Jennings, Graybar Building, New York City. With James A. Skene of Redding as superintendent, considerable equipment was installed here about 1930.

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[9] Ferguson, H. G., U. S. Geol. Survey Bull. 540-A, pp. 41–43, 1913.

A network of quartz veins occurs here in the Copley meta-andesite. They all have steep dips, and the strikes are in various directions; but they do not appear to be close enough together so that the whole mass can be mined. Skene was selecting lenses or shoots in these veins, which he stated would run $4 to $7 per ton in gold. Widths vary from a gouge seam to 1 and 2 ft. of quartz, with occasional swells to 5 ft. Several thousand feet of open cuts, 2 ft. wide and 3 ft. deep, some old, some new, expose this network of veins in an area scattered over two claims—40 acres. According to Skene, before the owner mentioned above acquired the property, $15,000 was produced from a shoot 36 ft. long above the 50-ft. level. These workings were under water at time of visit. They were stated to consist of a 63-ft. shaft with 181 ft. of drifting to the south and 137 ft. to the north on the 50-ft. level, two crosscuts, each 20 ft. long, and a raise to the surface from the north drift. No work has been done on the property recently.

Equipment consisted of air-hoist, 2 cylinders, 6 by 8 inches, single drum, headframe, bucket, bin, car, No. 5 Cameron sinking pump, Ingersoll Rand single-stage compressor belted to 60-hp. motor and connection to lines of Pacific Gas and Electric Co. There was also a mill consisting of a 9 by 15-inch crusher, Straub rib-cone ball mill, 3 ft. by 3 ft., Burdan pan-amalgamator. Rated capacity was 15 tons per 24 hours through a 40-mesh screen.

Paymaster Mine (No. 85) is a group of six unpatented claims in Sec. 3 ?, T. 33 N., R 8 W., assessed to P. X. Johnson and others of Lewiston. Late in 1931, the Broken Hills Silver Corporation was reported to have an option on the property, but apparently this was not exercised. By road, it is 33 miles northwest of Redding, half State highway, and half mountain road. Several hundred feet of drifting on quartz veins, on each of several levels, have been done here, and the veins stoped out. At time of visit, the main level was a 100-ft. crosscut adit, from which 400 ft. of drifting had been done. A 28-ft. winze from this level was stated to be in very good gold ore. This showed 3 ft. of quartz, and iron staining extending out into the walls for a width of several feet more. This stained material, Copley meta-andesite, was stated to be ore also by R. G. Bennett, who held an option on the mine at the time. The strike is east and west and dip 71° north. A 200-ft length of the vein had been stoped 80 ft. between levels, plus 75 ft. to the surface.

Bennett had a crew of five men and was operating a two-stamp mill, 36-inch Straub ball mill, 35-ton Overstrom concentrating table, and crusher. Power was furnished by gasoline engines of 8 and 10 horsepower. Treatment was amalgamation. No figures on production resulting from this operation were available.

Philadelphia and Roosevelt (No. 86) are an unpatented claim and a fraction in Sec. 17, T. 33 N., R. 7 W., in the French Gulch District, 24 miles from Redding. They are held by Tony Alexson of French Gulch, and are optioned and leased to W. A. Vogt of French Gulch. The Washington, Halcyon, and Niagara adjoin.

W. A. Vogt, working alone, is removing high-grade lenses of oxidized ore from the diorite-porphyry. Both walls are of this formation, decomposed and soft, but flat slate underlies the deposit. The lenses are from a few inches to 4 ft in width, and produce 15 to 30 tons each of ore that is stated to run $100 per ton in gold. It is a soft ochreous ore, yellowish and reddish brown, some black probably due to manganese; and it pans well in free gold. Mining is done by picking only, except that occasionally a mass of slate will require blasting. Ore has been shipped to the two-stamp mill of Earnest Blagrave, mentioned under the heading 'Hobo' above. The only treatment is amalgamation, and some of the quartz contains sulphides rich in gold, which is not recovered. Thirty tons of ore were mined and stacked ready for shipment, at time of visit.

Phillips Group (No. 87), also known as Laurel, is in Sec. 14, T. 32 N., R. 9 W., on Spring Gulch, a tributary of Indian Creek, 45 miles west of Redding, of which two miles is trail. The claims are held by J. W. Phillips of Lewiston. A small quartz vein, which the owner states gives very good assays in gold, is developed by a series of adits. The strike is northwest and the dip is vertical. The highest adit, 53 ft. below the outcrop, or 222 ft. above the level of the creek, is 160 ft. long, and exposes the vein with an average width of 6 inches, maximum, 18 inches. The next adit is 57 ft. below, and has a length of 130 ft. It does not follow the vein, but has the same general direction. A third adit, 100 ft. still lower, is 250 ft. long, and exposes the vein with an average width of 9 inches. Part of this is oxidized ore, and part sulphide, pyrite and sphalerite. The lowest adit level is about 20 ft. above the creek, and at distances of 67 ft. and 122 ft. from the portal, two raises have been driven through to the level above. This work exposes the vein with widths of one and 1½ ft. There is some work on the opposite side of the creek also, part of which has caved. An arrastre was operated here years ago, but no ore has been extracted recently.

Bibl: State Mineralogist's Reports XIV, p. 894; XVII, p. 541.

Porcupine Mining Co. (No. 88), a partnership of J. L. Maulen, Mrs. Maulen, Geo. E. Fenby and B. F. Blazier, has recently held a group of unpatented claims in Sec. 35, T. 32 N., R. 6 W., and probably extending into adjoining sections in the next township south. The group is 10 miles west of Redding, and is near the Oro Fino. It included the Last Chance, Tom Cat and Condensed, acquired from Wm. Moore of Redding; and the Porcupine and other claims were located later.

Considerable equipment, buildings, water-pipe lines, grinding machinery and jigs, were installed with the idea that the entire formation in the vicinity, called 'porphyry' by the operators, but probably quartz diorite, contains enough gold to pay if worked on a large scale. Where these principal operations were contemplated, development work consisted of an adit, 20 ft. long, with a raise to the surface, and an open cut 15 ft. deep. On a detached claim, the Condensed, there was stated to be a 60-ft. incline and 70 ft. of drifting on a quartz vein. The latter was not visited. Only a small amount of material was milled; and the plant was then dismantled.

Potosi Land & Mining Co. (No. 89), c/o Bert W. Gibbs, Box 327, Oakland, holds 47 acres of patented mining claims in Sec. 22, T. 31 N., R. 6 W., in the Muletown District, 12 miles southwest of Redding. In 1931, Dr. H. C. Erno, W. R. S. Bewsher and Frank E. Gelhaus, all of Redding, took a lease and option on the property. About 1890, some production was made at the south end of the group from a 90-ft. shaft, which developed an ore-shoot, 100 ft. long and 4 to 16 inches wide of high grade ore, which was stoped out. Later work included the sinking of a 75-ft. shaft near the center of the group, and drifting 100 ft. north and 110 ft. south from the bottom. These workings are in good condition, but there were no ladders in the shaft at the time of the writer's visit.

The partners mentioned above installed a prospecting outfit consisting of Quincy portable type compressor driven by a 70-hp. gasoline engine, a small air hoist and a headframe for a new shaft, which was put down about 50 ft. Early in 1932, a small mill was constructed consisting of 3½-ft. Huntington mill, crusher, 6 by 8 inches, amalgamating plate, and small concentrating table of Wilfley type, all driven by a 10-hp. gasoline engine. This was run for a time on oxidized dump-ore, and ore from open cuts. Additional prospecting by Gelhaus then exposed a shoot of good ore on the surface just north of the 75-ft. shaft. He removed 16 tons of this and put it through the mill, with a resulting clean-up from the plates stated to be $1110. This strike brought about the sale of the lease and option to Spring Gulch Mining Co., which is reported to be installing a 50-ton mill using amalgamation and table-concentration. Dr. Chas. Harvey of Marysville and Redding is in charge.

The vein is exposed at intervals by surface cuts for a length of about 200 ft. with widths varying from 16 inches to 3 and 4 ft. Depth reached in the cuts is 10 ft. The ore is quartz containing pyrite where not oxidized; but in the cuts, it is practically all oxidized and the gold is free, and in very small particles. The bottom of the 75-ft. shaft is in the sulphide ore. The deposit is associated with the intrusive contact of quartz-diorite into Copley meta-andesite.

Bibl: State Mineralogist's Reports XII, p. 254; XIII, p. 363; XIV, p. 796.

Rainbow Prospect (No. 90) is a group of four claims in Sec. 32, T. 32 N., R. 8 W., 15 miles southeast of Douglas City by steep mountain road. It is held by Mrs. L. L. Kelley of Fresno. W. H. Collins has an option on the property, and has recently made some open cuts with the idea of milling the surface material. Older work is on a flat quartz vein, nearly parallel to the hillside, showing a few inches to 2 ft. of white, sugary quartz. About four years ago, W. B. Wilson put some of this through an arrastre with good results. The prospect was idle when visited.

Bibl: State Mineralogist's Report XXII, p. 24.

R. A. M. and Little Alice (No. 91) are two groups of four unpatented claims each, held by C. H. Foster and James McLaughlin of Redding, in Sec. 24?, T. 34 N., R. 9 W. They are on Montgomery Ridge, and a road forking from the Buckeye Ridge road near Minersville reaches them. At the time of visit, in June, 1932, C. H. Foster was opening and widening an old, caved tunnel on the Little Alice group. This was driven on a dike of soft, yellow, decomposed rock, which shows white spots, apparently originally feldspar crystals. In the dike are seams of quartz, one inch wide, which pan gold. Foster states that an average sample taken from the dump material removed in opening the tunnel assayed $12 per ton in gold. He was working at a point 40 ft. from the portal.

On the R. A. M. group, just to the west, a 40-ft. cut exposes a 3-ft. width of red and brown hematite, with some yellow limonite, containing bunches and small lenses of quartz that pan gold. Additional work is to be done here to locate the source of quartz piled on the dump from some cuts made years ago. Country rock is a dark-gray, fine-grained, basic appearing rock, where seen in the fresher exposure. It is all much decomposed, and fractures are heavily stained with reddish-brown oxides of iron. This country rock is common to both groups of claims.

The Little Alice group has recently been reported to have changed hands. Machinery including a Gibson mill is to be installed.

Rattlesnake Prospect (No. 92) is in Sec. 8, T. 31 N, R. 5 W., five miles west of Redding. There are several surface cuts on different quartz veins in the Copley meta-andesite. Widths as great as 6 and 8 ft. were noted. Several hundred feet of crosscut adits have also been driven to prospect smaller veins. The owner, L. A. Davison of Delta, has recently been prospecting for pockets on the property. Equipment includes a small crusher, Gibson mill and gasoline engine.

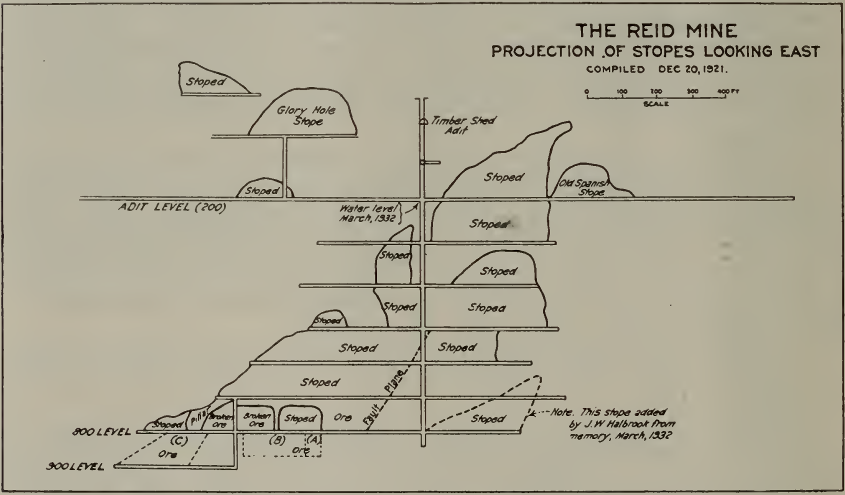
THE REID MINE
PROJECTION OF STOPES LOOKING EAST
COMPILED DEC 20, 1921.
0
100
200
300
400 FT
SCALE
Stoped
Glory Hole Stope
Timber Shed Adit
Stoped
Stoped
Old Spanish Stope
ADIT LEVEL (200)
Water level March, 1932
Stoped
Stoped
Stoped
Stoped
Stoped
Stoped
Stoped
Stoped
Stoped
Fault Plane
Stoped
Pillar
Broken Ore
Broken Ore
Stoped
Ore
Stoped
Note. This stope added by J. W Halbrook from memory, March, 1932
800 LEVEL
(C)
Ore
(B)
(A)
Ore
900 LEVEL

FIG. 6. The Reid Mine, projection of stopes, looking east. (See description No. 93.)

Redding Consolidated of Nevada, see Boswell.

Reid Mine (No. 93), c/o D. V. Saeltzer, Redding, California, is located in Sec. 3, T. 32 N., R. 5 W., in the Old Diggings District (which see), a map of which is contained in this report. It is 10 miles north of Redding, and about one mile from the station, 'Central Mine,' on the Southern Pacific Railroad, with which it is connected by an aerial cable-tramway. There are 10 patented claims and fractions of a total area of about 140 acres.

The mine was operated continuously, from 1907 to the summer of 1919, by the owners, James and Harvey Sallee; and ore was shipped to the Mammoth smelter at Kennett, where the silica was particularly desirable as flux. When this smelter suspended operations in the summer of 1919, the mine was closed, as there was no longer a market for the ore. The mine was allowed to fill with water, and was idle and inaccessible until the fall of 1923, at which time it was optioned to Chas. H. Palmer, Jr., and associates of Los Angeles, who unwatered the workings, thoroughly sampled the ore exposed on the lower levels, and completed a small amount of development work on the 800 level, north of the shaft. The unwatering required about 90 days, and cost $7500 for labor, power, supplies and equipment. Harvey Sallee, who was then the owner, afterward operated the property for a short time, and shipped several thousand tons of siliceous ore to the Bully Hill smelter, and to the Kennett smelter during its last period of operation. After a few months, all operations were suspended, in the summer of 1925. The mine was again allowed to fill with water, and has since been idle.

The vein occurs in a fissure in andesite, and both walls are well defined, particularly the hanging wall, which is evidently a fault plane. The vein filling is white quartz of a sugary nature, and is easily broken and crushed, although it stands well while being mined. Values occur as gold with a small amount of silver, associated with pyrite and a small amount of chalcopyrite. These sulphides are usually disseminated throughout the vein, but occasionally occur in a more concentrated manner, in bunches and streaks in the vein, to produce high-grade ore. It is thought that gold tellurides occur also. The vein is offset in several places by cross-faults, with small displacements; but no faults of notable magnitude have been encountered. Most of the ore produced came from an oreshoot with a maximum length of 600 ft., having a steep rake to the north. The strike of the vein is north-south, and the dip 70° east. The width varies from a few inches to 25 ft., but the average width is nearer 10 feet. A large rhyolitic dike is found on the surface just to the east of the mine, but apparently it does not appear in the workings.

Equipment includes a head-frame, hoist-house, double drum electric hoist, three Ingersoll-Rand air compressors with a combined capacity of 1200 cubic feet of air per minute, machine and blacksmith shops, aerial cabletram and terminals, with ore-bins at the mine and at the railroad. Equipment is partially dismantled, especially the electrical equipment, and will require repairs before it can be used. The two-compartment, 1000-ft. shaft will also require some retimbering, particularly above the adit level.

Details of development are indicated on the accompanying 'Projection of Stopes' (Fig. 6), hence no attempt is made to describe them in this text. The blocks, A, B, and C, of partly developed ore between the eighth and ninth levels are taken from a report by H. W. Stotesbury, who was in charge of work done by the Palmer interests. Much of the other information herein contained on the Reid mine is derived from the same report. His sampling indicated that these blocks, if stoped to a width of 7 ft., contain possible ore to the amount of 14,290 tons of $4.04-ore, or if stoped to a width of 15 ft., 34,380 tons of $3.50-ore. Gold is the only metal considered in these estimates. This is a low grade of ore, but much of the ore from the mine has been twice and three times as high in grade, and even higher. For instance, from February, 1907, to February, 1909, 34,600 tons of a gross value of $9.64 per ton were shipped. In the later years of operation, when ore was being mined primarily for smelter flux, there was little incentive to do the development work necessary to locate high-grade shoots, as is discussed in greater detail in this report under 'Old Diggings District.' If development work is planned to locate such shoots, it seems probable that a good grade can be maintained, similar to that of some of the earlier operations. An interesting thing brought out in Stotesbury's report is that a parallel vein to that on which most of the work has been done is probably exposed on the lower levels, and ore-shoots might be developed in this second vein. The possibility of working the Reid in conjunction with other mines of the district is mentioned herein under 'Old Diggings District.'

Bibl: State Mineralogist's Reports XIV, p. 797; XVIII, p. 408; XIX, p. 11; XX, p. 15; XXII, pp. 176-78.

Sam Houstan (No. 94) is a single unpatented claim in Sec. 34, T. 33 N., R. 5 W., in the Churntown Mining District, held by Roy Goll of Redding. It is 10 miles north of Redding, the last mile being trail at present; but an old road that reaches the claim by way of the Reid mine could be repaired at small cost. The deposit is a quartz vein associated with a rhyolitic dike in Copley meta-andesite. A surface cut shows 14 inches of quartz, from which Goll took a sample recently that is stated to have given an assay return of $10.10 in gold. Fifty feet lower is an 80-ft. tunnel crosscutting to an 18-inch vein, from which some ore is stated to have been stoped years ago and shipped to the Keswick smelter. The stope is caved. To the east, at a distance of 100 ft., is a 25-ft. adit on a steep vein varying in width from a few inches to 3 ft. At the portal is an 80-ft. shaft on the vein, showing that it has a very steep dip. Roughly 250 ft. lower in elevation than the bottom of the shaft is an adit, 380 ft. long, that was started to crosscut for the same vein, which has not yet been reached. Most of this adit was driven 25 years ago, but some of the assessment work has been done in it during recent years.

Bibl: State Mineralogist's Report XIV, p. 797.

Scottish Chief and Santa Clara, see Menzel.

Shasta Superior Mining Co., see Boswell.

Shasta View (No. 95) is a group of 21 unpatented claims and a millsite in Sec. 26, 27, 34, 35, T. 32 N., R. 6 W., seven miles west of Redding, held for a number of years by F. A. Zimmerman of Redding. At the time of visit, it was stated that a corporation, Shasta View Gold Mining Co., Ltd., was being organized to work the property. D. M. Thies was stated to be president and Gilbert A. Nelson, secretary, address: 317 Clem Wilson Building, 5225 Wilshire Boulevard, Los Angeles. Homer I. Reynolds, Box 24, Redding, was on the ground as manager. He stated that a mining engineer's report made years ago shows a large body of commercial ore near the surface at a point 200 ft. ahead of the face of the main adit level. Workings on which this estimate was based have caved. Where the exposure was observed on the surface by the writer, a width of 6 or 7 ft. of white quartz was seen. This appeared to narrow farther ahead on the strike. The outcrop of another and somewhat larger lens of quartz was observed a few hundred feet beyond. The main adit level starts near creek level, and follows a shear-zone in a fine-grained dike, probably rhyolitic, in the quartz-diorite. Quartz lenses from a few inches to a foot wide occur in this shear-zone, and considerable disseminated pyrite is found throughout the shear-zone. The adit is 510 ft. long, 7 by 10 ft. outside timbers, and is timbered the entire length with drift sets of 12 by 12-inch square timbers. The direction is southwesterly. Equipment consisted of blacksmith shop, a number of other small buildings and a single-stage duplex compressor belted to an automobile engine.

When the property was visited in February, 1932, Reynolds was planning to drive the main level ahead, and install immediately a 120-ton mill using jigs, and to ship the concentrate to a smelter. At this time (Sept. 1932) the work has not yet been started; but another sale of the property has been reported. Workings on the opposite side of the mountain, facing the Mt. Shasta mine, were not visited.

Bibl: State Mineralogist's Reports XVIII, p. 256; XX, p. 15.

Snyder, see Clipper.

Spring Gulch Mining Co., see Potosi, also North Star.

Summit Mine (No. 96) (Summit Gulch Mine; Summit and Montezuma) is in Sec. 17, 18, 19, T. 33 N., R. 7 W., near the summit of the Tom Green road between French Gulch and Lewiston. The distance from Redding is 25 miles. There are eight claims in different groups, owned by various partnership combinations of J. H. Porter, L. W. Wheeler, M. A. Corliss, and Mrs. A. V. Fondahn, all of French Gulch.

Wheeler has been working on one claim of the group owned by himself. The formation is slate intruded by igneous dikes. A fissure vein of ribbon quartz with an average width of 2 ft., maximum 5 ft., strikes N. 25° E., and dips 60° E. He sank a winze on the vein from a 100-ft. drift adit, to a depth of 65 ft. This is stated to be in a pay-shoot, but it was full of water at time of visit. Another adit was later started at a point 170 ft. below the first, and driven for 400 ft. Several ore-shoots were found in this distance and were partly stoped out. The ore was milled in a 5-ft. Huntington mill using amalgamation, but difficulty was experienced in making a good recovery from the last ore treated, due to the sulphide content. Recently a 50-ft. winze has been sunk from this lower adit level, and 20 ft. of drifting done to the north. In these exposures, the vein varies in width from 6 inches to 3 ft., and is stated to run $6 to $8 per ton in gold. Additional drifting is to be done to pick up the better shoots.

On the adjoining Brown Bear claim, owned by J. H. Porter and the Wheeler estate, at least 2000 ft. of workings are open, exposing considerable ore in widths of 2 ft. to 4 ft., that is stated to assay $7 to $8 per ton. High-grade shoots have been removed by different lessees. An adit called the Galena tunnel, 540 ft. long, exposes some of this ore; and 150 ft. lower in elevation, the Barnes tunnel, 1012 ft. long, exposes more of it. From both workings, high-grade shoots have been stoped. From the Barnes level, a raise, about 150 ft. high, from the sides of which ore has been stoped at various elevations, is open. Below the Barnes level is a connection to the old workings of the Tom Green mine adjoining, adits of which have caved at the portals. A plan map of Wheeler's workings and sketch longitudinal projection of the older workings are on file in the Redding office of this division. J. H. Porter is one of the owners of the Tom Green group (which see).

Bibl: State Mineralogist's Report X, p. 641; XIII, p. 365; XIV, p. 799; XVIII, pp. 206, 256. U.S.G.S. Bull. 540-A, p. 61.

Sunny Hill Mining Co. (No. 97), c/o Mary Marsicano, 781 Green St., San Francisco, is the owner of a property in Sec. 1, T. 30 N., R. 8 W., seven miles west of Ono. The mine was a producer some 40 years ago from a rich surface shoot, from which shipments were made to smelters. Widths are stated to have varied from a very narrow seam to 4 ft. Later ore was milled on the property and cyanided. The cyanide equipment has been removed, but the 5-stamp mill is still there.

L. F. Barlow of Ono is driving a lower adit level, which it is stated will cut the vein at a point several hundred feet below the lowest of the old workings. It is in 800 ft., and 1200 ft. more will be required to reach the vein, according to estimates. The country rock here is a schist varying in appearance from dioritic material to serpentine.

Bibl: State Mineralogist's Reports XII, p. 257; XIII, p. 365; XIV, p. 799.

Sybil Mine (No. 98) (Shasta Hills, Accident, Anaconda) is a group of 20 unpatented claims in Sec. 7, T. 33 N., R., 7 W., of a total area of 360 acres, held by L. Von Krusze and G. A. Von Krusze of French Gulch. It is 26 miles from Redding by road, 18 miles highway, balance mountain road.

The deposit is typical of the French Gulch District—quartz veins associated with dikes of diorite-porphyry in slate. The quartz contains pyrite, sphalerite, galena, arsenopyrite, and free gold. The only level now open is called the sixth. Levels above this developed the vein at short intervals to the outcrop, 200 ft. above the sixth level. A shaft below the level, now full of water, is stated to be down 150 ft., and to have developed a shoot of ore 90 ft. long, average width 4 ft., with a variation in width from 2 ft. near the ends to a maximum of 9 ft. at the middle. The shoot has been stoped out. Where exposed on the bottom level, its assay value is stated to be $5.42 per ton. Ore extracted is said to have varied in value from $30 to $600 per ton. A 2-inch Cameron pump, running 8 hours per day will keep the water out of these workings. G. A. Von Krusze is driving a crosscut from the sixth level, by hand, in the slate, in search of a vein that he states was exposed on the No. 2 level. He has driven 75 ft. and expects to drive 50 or 60 ft. farther. Veins strike southwest and northeast, and are nearly vertical in dip. The best ore has been found where a slate contact comes in on the hanging wall of a vein. The intersection of such a slate-porphyry contact, near the shaft mentioned above, has a dip to the south, and gives the ore shoot a rake in that direction. Footwall is diorite porphyry.

L. Von Krusze has recently stoped, underhand, a small stringer near the shaft or winze, and treated the ore in a mill of the cannon-ball type, driven by a gasoline engine. Treatment was amalgamation. The stope goes down about 10 ft. to the water-level. A lower tunnel, called the Accident, has been started to tap the mine 540 ft. lower in elevation. It is 800 ft. long, and 400 ft. more will be required to reach the vein, according to the owners. The portal is caved. This tunnel is stated to expose a 4-ft. vein that will free-mill $8 per ton; and some stoping has been done on it.

The mine is connected to the lines of the Pacific Gas and Electric Co. Equipment includes a 12 by 12-inch Rix single-stage compressor, driven by 50-hp. motor, 15-hp. electric hoist, several small pumps, cars, track, blacksmith shop, bunk house, boarding house, and other buildings. The mill is equipped with a crusher and 7-hp. motor, 5-stamp battery, 1200-lb. stamps, with a 15-hp. motor, and a Senn vanner.

Bibl: State Mineralogist's Reports XIV, p. 777; XVIII, pp. 43, 138, 296, 408; XIX, p. 11; XXII, pp. 178–79. U. S. G. S. Bull. 540, pp. 68–69.

Texas Mine (No. 99) comprises 7 patented claims and a fraction in Sec. 33, T. 33 N., R. 5 W., in the Old Diggings District, 10 miles north of Redding. (See 'Old Diggings District' and map of that district). The property is owned by Mrs. Mary B. Garlick, 2243 Franklin St., San Francisco, for whom W. D. Tillotson of Redding is local representative. It has been idle for a number of years, and portals of adits have caved, making workings inaccessible. Information given here is derived from State Mineralogist's Reports listed below and a report and notes furnished by W. D. Tillotson.

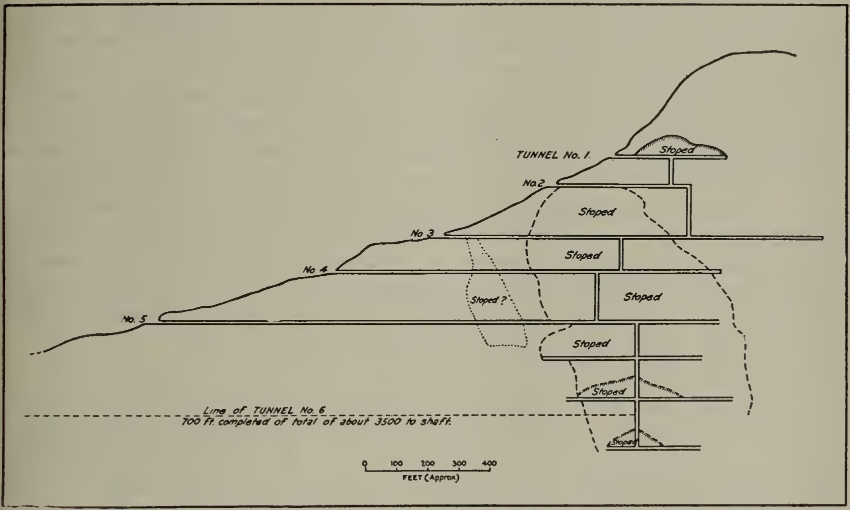

FIG. 7. Sketch projection of underground workings of Middle vein, Texas Mine, from data furnished by W. D. Tillotson of Redding. Stopes are shown the same as on original, but Tillotson says that all within the dotted lines has been stoped. (See description No. 99.)

Gross production is roughly estimated at $750,000. According to notes of the late Dr. Garlick, who owned the mine, he was able to find receipts of sales of bullion, amalgam, concentrates, and ore totaling $403,747. However, he was unable to complete the record, receipts for various periods being missing.

The property is known to contain three different veins, but development has been confined largely to one of them, the Middle Vein, work on which is shown on the accompanying sketch-projection (Fig. 7). The width is reported as varying from 4 to 14 feet. A little ore was also produced from the East Vein near the surface. A 20-stamp mill of 825-lb. stamps, concentrators, canvas plant, and chlorination works was operated here for a number of years about 1890. Mining was done by hand, and 75 men were employed. Capacity was about 40 tons per day. The last work was done by Harvey Sallee, in 1922–23, and consisted of crosscutting in a search for segments of the vein beyond a fault.

The bottom of the mine appears to be in a lean zone, but additional development work might pick up other ore-shoots. The Reid mine, just to the south, has produced from much greater depths. The possibility of grouping these old mines for economical working has been mentioned under the heading, 'Old Diggings District'.

Bibl: State Mineralogist's Reports X, pp. 629–30; XI, pp. 43, 396–97; XII, p. 258; XIII, p. 365; XIV, p. 800; XVIII, p. 206; XIX, pp. 11, 58, 137; XXII, p. 179.

Tom Green Mine (No. 100) consists of four unpatented claims in Sec. 17, 18, T. 33 N., R. 7 W., adjoining the Summit Mine (which see) in the French Gulch District. The owners are J. H. Porter, Chas. Fox and Henry Carter, all of French Gulch. The mine has been a producer in the past, but portals of adits are caved at present. However, some of the workings can be entered through a connection with the adjoining Summit mine, the adits of which are on the opposite side of the mountain. Some of the Tom Green workings are shown on a sketch longitudinal projection of the Summit mine on file in the Redding office of this division. In the summer of 1932, T. W. Kenny and Geo. H. Barber were installing a 5-stamp battery of 200-lb. stamps to treat dump material. Power was to be furnished by a 7-hp. gasoline engine.

Bibl: State Mineralogist's Report XIV, p. 800.

Trinity Gold Mine (No. 101) (Prospect) comprises six unpatented claims, 120 acres, in Sec. 6, T. 31 N., R. 9 W., held by Harry Paige and S. G. Lovejoy of Douglas City and Dr. H. E. MacDonald of Redding. From Redding, it is reached by 40 miles of State highway plus 7 miles of dirt road to the mine, which is located on a steep slope draining into Browns Creek.

The deposit consists of quartz stringers and a silicified zone in schist, which is stated to contain gold enough to make mining on a large scale profitable, providing a sufficiently large tonnage can be developed. The ridge to the west of Browns Creek rises to an elevation of roughly 1000 ft. above the creek. At a point 650 ft. above the creek, a cut 70 ft. long and 3 ft. deep exposes quartz stringers and silicified schist for the entire length. One hundred feet below is a 65-ft. tunnel in the same material. A new adit, 50 or 60 ft. above the creek, was being driven at the 110-ft. point at the time of visit. All of the country rock is schist, some of it greenish and chloritic, some slaty. All of it is silicified and cut by quartz stringers; but these are much more numerous in the upper workings than in the part of the new adit inspected. It was planned to drive this adit at least to the 300-ft. point. An assay sheet of samples stated to have been taken by O. M. Wilson, shows 19 samples with an average value of $3.53 per ton in gold. These samples were taken at various points on the surface and in open cuts, scattered pretty well all over Trinity No. 2 claim, and in the upper tunnel, which is just east of that claim. Widths of samples are not stated.

Trinity Mohawk (No. 102) includes 6 claims formerly held by J. H. King of Redding, which are being purchased by Vest F. McClelland, J. L. Gow, and W. H. Wing, also 12 additional claims which have been located by the three last named and Ed. Johnson. There is also a 5-acre millsite. The location is in Sec. 26, 27, T. 34 N., R. 8 W., 34 miles from Redding, 18 miles of which is State highway, balance steep mountain road.

In a quartz fissure vein heavily stained with oxides of iron, the operators state that 10,000 to 12,000 tons of $10-ore with an average width of 5 ft. is in sight. The vein has a dip of 35° to the north. On the main adit level, there are 200 ft. of drifting on the vein and several hundred feet of crosscutting. An intermediate, 40 ft. above, has 150 ft. of drifting; and 30 ft. above that, is a level with 130 ft. of drifting and a small stope with a hole to the surface 30 to 40 ft. above. Snow blocked the road to the mine during the winter, 1931–32, and development work was carried on with supplies packed up the mountain from Lewiston. New drifting amounting to 125 ft., and raising amounting to 40 ft. was done. Country rock is slate, with possibly an intruded dioritic rock. There is also a fine-grained siliceous conglomerate on part of the holdings. Other veins are known on the property, but development has been largely confined to one.

At the time of visit, 30 tons of ore had been run through a recently constructed mill consisting of a 40-ton Forrester-Rexman rod mill with a 30-mesh screen. This was equipped with a 2 by 5-ft. amalgamating plate bent to fit within a few inches of the peripheral discharge of the rod mill. There were also inclined plates below, 4 by 6 ft. and 4 by 5 ft. An exceptionally high extraction by amalgamation alone is claimed but sulphides will, no doubt, be found as development proceeds. Power is supplied by a 32-hp. gasoline engine. Ten men were employed in mine and mill.

Water supply for the mill is brought from the opposite side of the mountain through a new 8500-ft. line of 2-inch casing. When this was being laid, a new vein was found on the opposite side of the mountain from the main workings, on the slope that drains into Little Papoose Creek. This had been opened in three places by means of shallow cuts, indicating a possible length between cuts of several hundred feet. The surface quartz panned well in free gold, fairly coarse. More extensive development work was to proceed immediately on this.

Bibl: State Mineralogist's Reports XVIII, p. 498; XXII, pp. 26, 32.

Truscott Mine (No. 103) (Martin Mine, including the Iron Mask) is a patented quarter section, NE ¼ Sec. 36, T. 33 N., R. 7 W., owned by Mrs. John Martin of Redding, and recently leased to J. C. Clemence and F. E. Brewster. It is 18 miles west of Redding by State highway and 2½ miles of dirt road.

Clemence and Brewster installed prospecting equipment consisting of an 85-cu. ft. portable Gardner-Denver compressor driven by a gasoline engine, and a 4-inch ventilating fan driven by a small engine.

They started at the face of an old 213-ft. adit, and drove about 300 ft. to a slate-porphyry contact, on which some old stoping can be seen on the surface. This porphyry is of the "bird's eye" variety, probably andesitic. They found the contact, but no ore, and the work was abandoned. An old mill building contains a 14-stamp Straub mill, rated at 20 to 30 tons per 24 hours, also a 5-stamp mill of 850-lb. stamps, amalgamating plates and a circular concentrator. The old steam engine that drove this outfit is in poor condition.

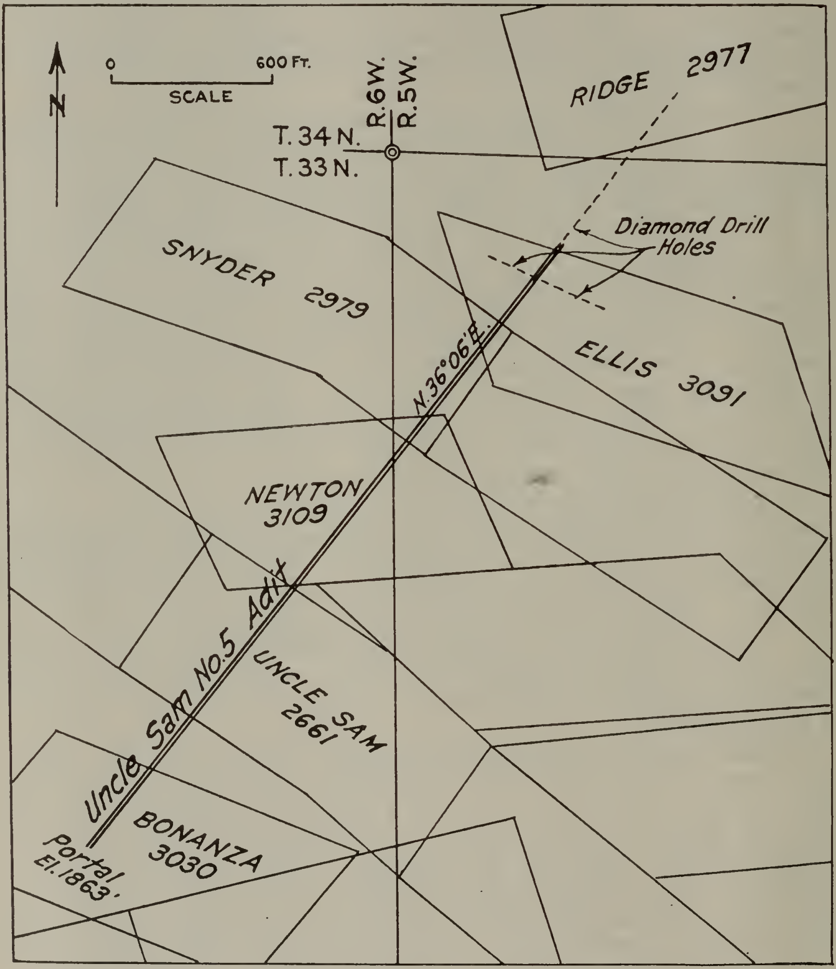
N
0
600 FT.
SCALE
R.6W.
R.5W.
T.34 N.
T.33 N.
RIDGE 2977
Diamond Drill Holes
SNYDER 2979
ELLIS 3091
N.36°06'E.
NEWTON 3109
Uncle Sam No.5 Adit
UNCLE SAM 2661
BONANZA 3030
Portal El.1863'

FIG. 8. Plan of Uncle Sam No. 5 adit and claims (with U. S. Mineral Survey numbers) through which it passes. (See description No. 104.)

Bibl: State Mineralogist's Reports VIII, pp. 571-72; XII, p. 248; XIII, p. 356; XIV, p. 802. U. S. G. S. Bull. 540-A, pp. 48-49.

Uncle Sam Mine (No. 104), consisting of a large acreage of patented mining claims, in Sec. 1, T. 33 N., R. 6 W., Sec. 6, T. 33 N., R. 5 W., Sec. 36, T. 34 N., R. 6 W., is the property of the Dakin Co., c/o

C. C. Dakin, Redding. It is one of the well-known, old gold-quartz mines of Shasta County, having produced over $1,000,000 in several years prior to 1913, when it was operated by the Sierra Buttes Mining Co. Plan of workings and projection of stopes are to be found in State Mineralogist's Report XIV, p. 801.

About 1923, the American Zinc, Lead and Smelting Co. of St. Louis drove the No. 5 adit to a point just beyond the north side-line of the Ellis claim (which see) and did several hundred feet of diamond drilling, in different directions, from points near the face. This work was done in a search for extensions or segments of the great bodies of copper ore known in the adjoining Mammoth mine of the U. S. Smelting, Refining and Mining Exploration Co.

In driving this adit, several quartz veins of good size were cut in holdings to the north of those of the Uncle Sam; but they were not developed. These veins are attracting attention at present as good gold prospects. The difference in elevation between the adit level and the surface affords backs of 1000 ft. and more.

The adit has recently been opened to such an extent that the face can be reached for inspection, but several small caves must be cleaned up to make it serviceable. The 6-mile road up the mountain from the Squaw Creek bridge near Kennett is entirely washed out, and many stretches must be entirely rebuilt. A 10-stamp mill in a partially wrecked condition stands near the portal of the No. 5 adit.

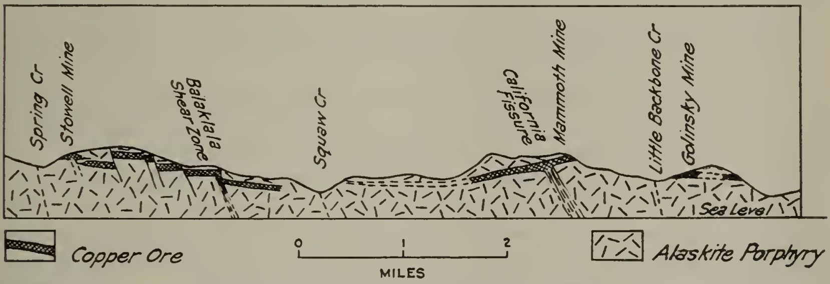

FIG. 9. Idealized longitudinal section, looking northwest, of a part of the Shasta County Copper Belt, adapted from an unpublished section by M. E. Dittmar. Deposits of gossan are found at the surface, where ore-bodies outcrop. (See description No. 5 and No. 105.)

Bibl: State Mineralogist's Reports X, pp. 310, 639; XI, pp. 47, 395, 398; XII, pp. 258–59; XIII, pp. 367–68; XIV, pp. 802–03; XIX, p. 56; XX, p. 15.

United States Smelting, Refining & Mining Exploration Co. (No. 105) (Mammoth Copper Mining Co.), 1 State Street, Boston, Mass., owns thousands of acres of mining claims in Sec. 2, 3, 29, 31, 32, 33, T. 33 and 34 N., R. 5 W., near Kennett. A copper smelter of 2200 tons daily capacity was formerly operated at Kennett, but it has recently been junked. A description of the copper mines and map of the holdings are contained in the April, 1926, chapter of State Mineralogist's Report XXII, copies of which are available at offices of this division at 25¢ each.

Interest has recently been shown in regard to the possibility of producing gold from the gossan here by the process used by the Mountain Copper Co. Apparently the Mammoth gossan deposit is much smaller than that of the Mountain Copper Co., but the necessary development work to actually determine the tonnage is lacking. An engineering examination of the gossan with rather extensive sampling was made about 1931, but the company will not give out the results of this.

The company owns also two patented claims in the Old Diggings district (which see), from which some gold-quartz ore has been produced from shallow workings. These claims are of interest as possible members of a large group that could be formed at Old Diggings for economical mining and milling of the ore.

Bibl: State Mineralogist's Reports XIV, pp. 767–69; XX, pp. 435–38; XXII, pp. 150–54. Bull. 50, pp. 95, 97.

Utah and California Mine (No. 106) (Walker Mine), consisting of 12 patented claims and fractions in Sec. 3, 4, 10, T. 32 N., R. 5 W., in the southern part of Old Diggings District (which see), owned by Walker Bros. of Salt Lake City. It was formerly a producer equipped with a 10-stamp mill, but has been idle for years; and there is no equipment. At this time (Oct. 1932) the lowest adit level is being opened for an engineering examination and possibly new development work.

Bibl: State Mineralogist's Reports X, pp. 630–31; XI, p. 397; XII, p. 259; XIII, p. 368; XIV, p. 803.

Venecia Mine (No. 107) (Eastman Consolidated Mines Corporation) comprises 13 claims, of which one is patented, in Sec. 3, T. 33 N., R. 8. W. The distance from Redding is 34 miles, half highway and half mountain road crossing a 4000-ft. summit. Paulsen Bros. of Lewiston are the owners, and have given a lease and option to the corporation named above, which had two men at work at time of visit. Three quartz fissure veins with vertical dip, varying in width from a few inches to 5 ft., occur. The ore is base, containing quartz, gouge and iron, zinc and lead sulphides. Country rock is Copley meta-andesite and quartz diorite, and a little slate.

Development work consists of a No. 3 level with 200 ft. of workings open, largely drifting on the Venecia vein, balance caved; also a No. 5 level with 1000 ft. of workings of which 500 ft. is drifting on a small fault vein showing gouge and a few inches of quartz. A crosscut was being driven on the No. 5 level to the Venecia vein at time of visit. An intermediate between these levels is 350 ft. long. W. G. Carlson, who was in charge of the work, estimated 5000 tons of ore of a good grade in sight.

Equipment consists of an 8 by 8-inch Sullivan compressor with a 60-hp. engine, machine drills, cars, rails, pipe, etc.; also a 6-ft. Huntington mill. None of the machinery was in service at time of visit.

Bibl: State Mineralogist's Reports XVIII, pp. 207, 497; XIV. p. 900.

Veteran, see National.

Victor, see Harrison Gulch.

Walker, see Utah and California.

Washington Gold Mining Company (No. 108) is controlled by Dr. Geo. Grotefend of Redding. This patented property is in Sec. 16, 17, T. 33 N., R. 7 W., and covers most of the hill between the forks of French Gulch. It was located in 1852, and is one of the oldest quartz mines in the State. For 50 years it was operated on and off, and produced a total amount of gold variously estimated at between $1,000,000 and $2,000,000.

Through a series of six adits, it has been developed at various elevations from near creek level, elevation 2000 ft., to a point near the top of the ridge, elevation 2900 ft. The upper workings are partly in the Bragdon slates with the dikes of intruded soda granite-porphyry characteristic of the French Gulch district. Copley meta-andesite is found in some of the lower workings. Two main veins have been worked, one striking north and dipping east, the other striking a little north of east and dipping north. Small stringers found in the vicinity of dikes have also yielded considerable ore. Stoping widths of 5 ft. and more have been found on the north-south vein, which was the largest. Ore is principally white quartz with small quantities of galena, sphalerite, pyrite and arsenopyrite.

Recently (summer, 1932) the I (eye) level, 270 ft. above the creek, has been cleaned out and retimbered for a distance of 600 ft. Some 50 ft. beyond this is a small cave under a raise, and 50 ft. beyond the level is closed by caving. Some small quartz veins are seen in branches of this level. On the H level, 220 ft. above the I, 1000 ft. or more of work is open, and quartz veins with widths of 2 to 5 ft. are seen. The G level is caved at the portal. The F or Trimbath level, 715 ft. above creek level, is partly open, and the north-south vein, which was the principal producer in the early days of the mine, can be seen. According to Wm. Blagrave of French Gulch, a former lessee, the ore-shoot on this vein had a rake to the north, and development work to the north on some of the lower levels should pick it up. Some hundreds of feet of intermediate levels are also open. A detailed mapping of all open workings, with plotting strikes and dips of all veins, faults, dikes and contacts should be of great assistance in locating new ore in this old mine.

A cut on the surface, high on the ridge, recently yielded 12 tons of ore, from which Dr. Grotefend states $725 in free gold was extracted. There is an old five-stamp mill on the property.

Bibl: State Mineralogist's reports X, pp. 635-36; XI, p. 50; XII, p. 260; XIII, p. 368; XIV, p. 804; XVIII, p. 43; XIX, p. 11; XXII, p. 179–80. U.S.G.S. Bull. 540, pp. 35, 37, 44, 64–66.

Woodfill, see Beaver.

Yankee Jack Mine (No. 109) (Yankee John) is a group of three unpatented claims in Sec. 17, T. 31 N., R. 5 W., 6 miles southwest of Redding by road. It is held by John F. Reese and W. L. Hill, both of Redding.

The 300-ft. shaft is kept unwatered to the 200-ft. level by the owners. This requires bailing for 20 minutes per day. The 300-ft. level has not been accessible recently. According to maps and reports, all work on the 300 was to the northeast; while on upper levels, ore recently discovered was to the southwest of the shaft. On the 200-ft. level, on the north side of the shaft, there is a 35-ft. crosscut to the main vein, on which is a 100-ft drift to the west. The average width is 5 ft., with a maximum of 8 or 9 ft. where the vein splits near the west face. Owners state that this ore runs $10 per ton in free gold, or $12 to $13 total including sulphides. The drift also extends to the east of the crosscut, exposing smaller widths, but the grade of part of this is stated to be higher. In the crosscut, at a point 15 ft. north of the shaft is a drift on a parallel vein 2 ft. wide, which the old Yankee John company stoped out, about 1915. This vein is said to have been considerably wider on the 160 ft. level, which was not open at time of visit. A third working on the 200 level is a crosscut in an easterly direction from the shaft. At 35 ft. from the shaft, this struck a stringer from which a pocket was taken by means of a 20-ft. winze. At a distance of 180 ft. from the shaft, a vein is exposed which is stated to assay $7 to $12 per ton for a width of 10 ft. Ore in this vein is a soft, partially oxidized quartz in contrast to that of the vein where most of the work has been done, which is a hard white quartz containing pyrite, and minor quantities of other sulphides. The soft ore has been exposed for only a few feet along the strike, but it appears to be a promising prospect.

On the 100-ft. level, the old crosscut was driven 16 ft. northwest from the shaft, then turned to the west for 100 ft., not on the vein. Reese and Hill have crosscut to the north 25 ft. from the old face, and have struck the main vein, then drifted west for 45 ft. They extracted 50 tons from this drift that is stated to have yielded $2,000 in free gold. There is stated to be considerable gold in the sulphides which went into the tailing also. Ore above the 70-ft. level was stoped out years ago. Country rock is Copley meta-andesite, but slate is to be seen on the surface just to the east of the shaft. Andesitic dikes with larger feldspar phenocrysts than those of the Copley meta-andesite are found on the north side of the main vein, but appear to strike at an angle with the vein.

Equipment consists of a 9 by 12-inch single stage compressor, and a hoist, both driven by one 15-hp. gasoline engine. The 10-stamp mill that formerly stood on the property has been removed. The ore treated recently was hauled to a mill on another property of Hill's, 10 miles north of Redding.

Bibl: State Mineralogist's Reports XVII, p. 524; XVIII, p. 495; XIX, p. 11.

GOLD (Placer)

Bigelow Ranch Placer (No. 110) consists of 100 acres of unpatented placer claims in Sec. 31, T. 32 N., R. 9 W., on Browns Creek, owned by Pearl Bigelow and Harvey Bigelow of Douglas City. In 1931, this was optioned to Harry Holloway, who sank several prospect shafts in the gravel, and washed out a few prospect pits with water pumped from the creek by means of gasoline engines. Recently (1932) the property has been idle.

Big Bend Placer Claim (No. 111) in Sec. 17, T. 33 N., R. 8 W., one mile north of Lewiston, and other property in Sec. 19 and 20, on the other side of Trinity River nearer Lewiston, have recently (May,

1932) been optioned by the owner, J. W. Phillips of Lewiston, to G. H. Harrison and brother of Watsonville. The total area of property controlled by Harrison Bros. amounted to 305 acres. An experiment was conducted here in pumping water from Trinity River to supply an ordinary giant for hydraulicking the gravel. The installation consisted of a Byron-Jackson double-suction centrifugal pump, built to order, and capable of delivering 4600 gallons per minute through 800 ft. of 15-inch pipe and a 3½-inch nozzle, with a pressure equivalent to a 320-ft. head. Power was furnished by a 300-hp. Westinghouse motor, 1760 r.p.m., connected to lines of the Pacific Gas and Electric Co. From a mechanical standpoint, the installation appeared to be a success; and a good stream under high pressure was delivered at the giant. However, the property was idle when visited in the fall of 1932. Some of the obvious difficulties were the lack of sufficient water to wash the gravel in the sluice, and the presence of a stratum of cemented gravel several feet thick next to the bedrock. At one time, the operators were considering the installation of a second pump to deliver water at low pressure for washing. The main consideration in an installation of this kind is whether or not the gravel contains enough gold to pay the operating expenses plus a proper return on the investment. Gold content of the gravel should be determined in advance of the installation of equipment by carefully prospecting the deposit through numerous holes drilled or sunk in a systematic way clear through the gravel to the bedrock. Operating expenses on such an installation are bound to be very high on account of the excessive power consumption due to the relative inefficiency of a stream of water in moving gravel as compared with a mechanical device such as a bucket-line on a dredge.

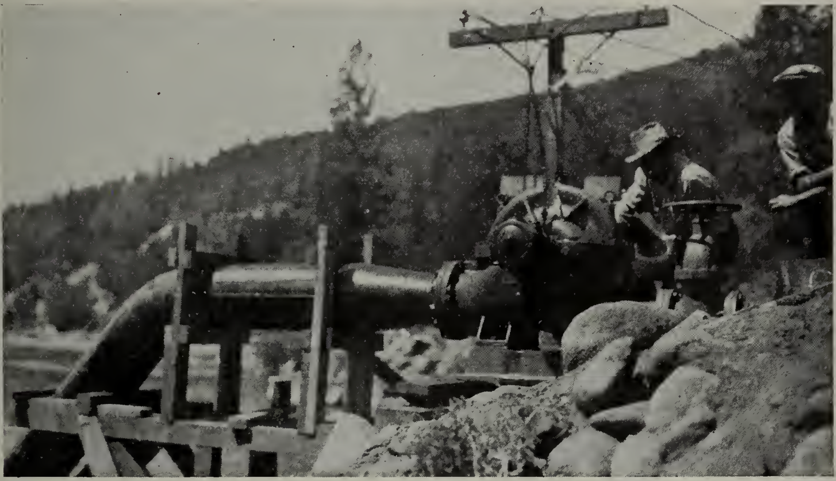

FIG. 10. Pump for hydraulicking at Big Bend placer. (See description No. 111.)

Bibl: (Phillips) State Mineralogist's Report XIII, p. 459.

Blue Gravel Mine (No. 112) is on land purchased by the City of Redding for the airport and lies just to the southwest of the latter.

About 1915, some good placer gold was found here by drifting methods. Total production is estimated at roughly $20,000. Of this, $7,000 was produced under the supervision of W. L. Hill of Redding. Some production has recently been made by George Dix, a lessee. Part of the work was done by hand, and later a ¼-yard gasoline shovel was tried.

Buckeye, see Majestic.

Clear Creek Placer Company (No. 113), a Washington corporation, is purchasing from James E. Paige 80 acres of placer ground on Clear Creek in Sec. 34, T. 32 N., R. 6 W. Directors of the company include C. C. Merriam of Seattle and S. C. Brady of Yakima. Under the supervision of G. L. Covington an attempt was made to mine the gravel with 1¼-yard Thew gasoline shovel, and to wash the gravel in a machine mounted on skids, and designed to be pulled ahead by the shovel as it advanced. This machine had been altered several times but was still in the experimental stage when last seen by the writer. Gravel was classified by means of grizzlies to sizes above and below 1½ inches. Oversize was stacked by means of a belt-stacker, and under size was treated on screens and carpet-tables to recover the gold. No adequate provision had yet been made for disposal of tailing at the lower end of the machine, which was interfering with its operation. The addition of a bucket elevator or sand and gravel pump was planned to overcome this difficulty.

Diving Bell Mine (No. 114) is a property of 40 acres in Sec. 26, T. 32 N., R. 5 W., just northwest of Redding, on the Sacramento River.

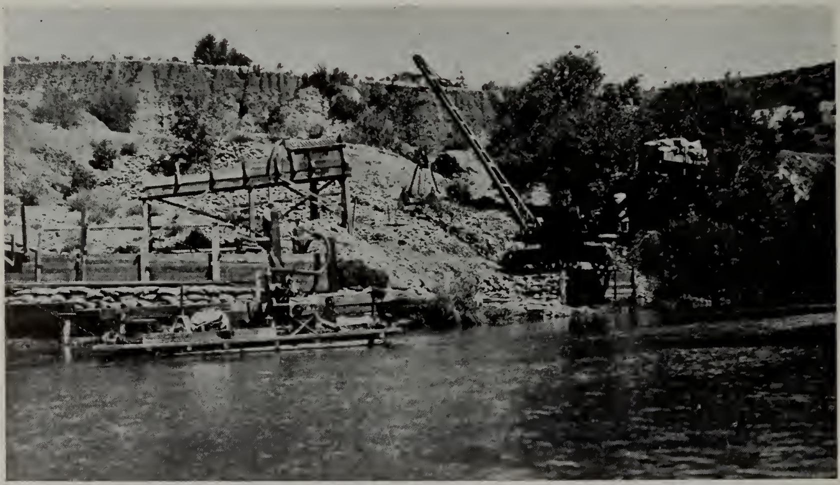

FIG. 11. Diving Bell Mine, near Redding. (See description No. 114.)

In 1932, L. Wells and Wm. A. Wells attempted to mine from the bottom of the river. Gravel of a depth of 12 feet was removed with a ½-cubic-yard clam-shell excavator set up on the north bank of the river (see photograph). This gravel was sluiced with water pumped from the river and yielded a little gold. The principal yield was expected to come from cleaning the hard, irregular bedrock by a man working in a diving suit. The excavator was principally for the purpose of removing enough of the overburden so that an area of the bedrock would be clean enough for the diver to work. Apparently excavating machinery of a greater range than that used is needed to accomplish this. James E. Carney of Redding is the owner.

Douglas City Group (No. 115) consists of eight claims, 820 acres, held by Dr. D. B. Fields of Weaverville in Sec. 1, 12, T. 32 N., R. 10 W. and Sec. 6, 7, T. 32 N., R. 9 W., covering gravels along the south bank of Trinity River between Indian Creek and Redding Creek.

According to a report of R. C. Eisenhauer, furnished the writer by Dr. Fields, 10 or 15 acres have been mined off at the west end of the property with results stated to be good. Work by ground sluicing and rockers was followed by small-scale hydraulic operations with water under low pressure. Some development work has also been done by B. R. Brown of Weaverville. Tunnel No. 1, 40 ft. long, on the Old Crow claim, is stated to have shown gravel of a value of 11¢ per cubic yard. Tunnel No. 2, 110 ft. long, starting at the north rim-rock on the Barley Field claim, is stated to have exposed gravel of a value of 11¢ to 14¢ per cubic yard. At 100 ft. from rim-rock, a winze was sunk 40 ft. without striking large boulders or bedrock. On the Silvia claim, near the top of the ridge, a 40 ft. shaft was sunk with reported values of 11¢ per cubic yard.

The late Pierre Bouery, who had charge of operations at the La Grange mine for 15 years, was working on a report on the Douglas City group shortly before his death. According to a partial report by him, a copy of which was furnished the writer by Dr. Fields, he thought that there is gravel enough here to make a very large hydraulic mine, providing all parts will yield the values indicated by development work mentioned. However a systematic campaign of development work will be required to definitely determine the yardage and the average gold content per cubic yard.

Water to the amount of 3000 miner's inches could be put on the property for a part of the year by extending the ditch from the Indian Creek and Panwocket (which see), six miles to the southeast. A head of 500 to 600 ft. would be available. For large-scale operations additional water will probably be needed.

Gardella Dredge on Clear Creek has been dismantled.

Gas Point Dredge (No. 116) (formerly Ogden and Wilson) is in Sec. 3, T. 29 N., R. 6 W., on the Roaring River just above where it flows into Cottonwood Creek, near Gas Point, or 15 miles by road west of Cottonwood. Chas. F. Staheli and J. L. Cerney of Anderson have operated the dredge on and off recently, and some production of both gold and platinum has resulted. The dredge is 75 ft. long by 36 ft. wide by 6 ft. deep and draws about 3 ft. of water. Power is furnished by an oil engine of 60 hp. burning six gallons of distillate per hour. There are 32 buckets of 2½ cubic foot capacity. Water for washing is furnished by an 8-inch Yuba pump. Oversize from a trommel with ⅜-inch holes is stacked by a belt conveyor, and undersize goes to a sluice with riffles. Capacity is 400 to 500 yards per 10-hour shift. The gravel that has been dredged is 8 to 12 ft. deep, and lies on a bedrock of volcanic material only a foot or two thick. Below this there is more gravel which has not been dredged, nor has it been thoroughly tested for values.

Gold Bar Dredging Corporation (No. 117). (A *Gardella* dredge burned at this locality some years ago.) This is a new company which has leases on 1000 acres of land on the Trinity River from the bridge at Lewiston down stream for five miles, in Sec. 18, 19, T. 33 N., R. 8 W. and Sec. 13, 23, 24, 26, T. 33 N. R. 9 W. The distance from Redding, the nearest railroad point, is 40 miles. Floyd R. Marsh is president, Chester E. McCarty is secretary, and Herbert Olson is superintendent. The home office is at 725 Yeon Building, Portland, Oregon.

A new dredge has been constructed, mostly under the supervision of E. E. Chenoweth, who was formerly in charge. The main hull, less overhang is 79 by 44 by 7 ft. The dredge is of the stacker type, and carries a bucket-line of 45 buckets of 7 cu. ft. capacity each, and digs to a maximum depth of 31 ft. below the water line. Gravel is dumped into a hopper, where it is washed with water under high pressure from two nozzles, then goes to a 24-ft. revolving screen, 4 ft. in diameter, where it is again washed with water under high pressure from several nozzles pointing in different directions. Largest boulders can be pushed off from the stacker-belt at the bottom, where the revolving screen discharges. The balance of the oversize is stacked. Undersize from the screens, which are drilled with holes from $\frac{1}{4}$ to $\frac{5}{8}$ inches in diameter, is treated on 3000 square feet of gold tables. These are arranged in the form of inclined sluices, 32 inches wide, equipped with riffles of 1 by 1-inch angle iron with a flat side turned to the top. The dredge is held in digging position by headlines of $1\frac{1}{2}$-inch steel cable only. No spuds are used. Electrical equipment is all first class, wired in conduit and with metal terminal boxes. It includes an automatic contactor system for the controller to pick up the load gradually. Power is delivered by the Pacific Gas and Electric Co. at 4400 volts, and is stepped down on the boat to 440 volts with three 100-kw. transformers. Motors are 150-hp. main digging motor, 30-hp. on 8-inch pump, 50-hp. on 10-inch pressure pump for nozzles in screen and hopper, 40-hp. for 7 drum winch and hoist. The dredge is equipped with two fire-fighting systems, water hydrants connected to pressure pump, and large soda-acid extinguishers, one of which is mounted on a cart. The cost of the dredge, not counting some metal parts of the old dredge, which were utilized, was $82,000.

The initial cleanup of a run started on August 16, 1932, of seven days, counting actual running time only, is stated to have returned 18¢ per cubic yard from 18,000 yards. This came from a bar that was dredged to a width of 300 ft. and a depth of 15 to 20 ft. The dredge is run three shifts per day with a total crew of 22 men. Drilling of the holdings of the company is stated to have shown an average gold content of the gravel of 17¢ per cubic yard.

Bibl: (Gardella Dredge) State Mineralogist's Report XVIII, pp. 297, 496, 601, 734.

Hook and Ladder (No. 118) is an old hydraulic mine in Sec. 5, 6, T. 33 N., R. 9 W., just north of Weaverville, which has been worked intermittently in a small way for many years. Water was bought from the La Grange Company for a short run of two months in 1929. In the summer of 1932, Trinity Exploration Co. attempted to mine the gravel here with a power-shovel, and treat it in a machine consisting of a revolving screen, sluice and belt-stacker (see photograph). The property was idle when visited.

Bibl: State Mineralogist's Reports XIV, p. 907; XXII, pp. 37, 54.

Igo Placer Mining Company (No. 119) has been prospecting 30 acres of gravel acquired from F. H. Russell, formerly part of his Lost Channel mine, in Sec. 34 ?, T. 31 N., R. 6 W., near Igo. John Ringus, 1276 Folsom St., San Francisco, was stated to be the owner, and C. O. Heynen, 400 Tesla St., Sausalito, Cal. was in charge of the prospecting. This consisted of advancing one tunnel 20 ft. and another 30 ft., and was stated to have exposed gravel of excellent grade. Several hundred feet of workings are open in the gravel in an old tunnel called the Stiller tunnel. Bedrock is a biotite-diorite, with a layer adjacent to the gravel usually decomposed.

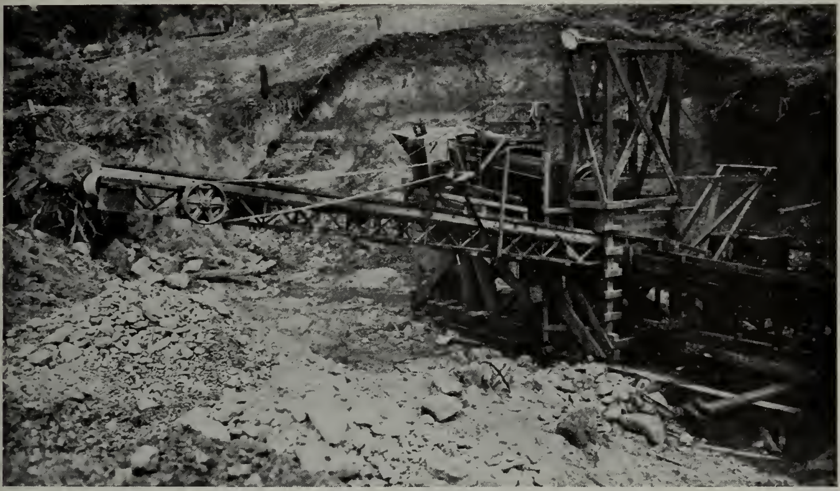

FIG. 12. Washing machinery at Hook and Ladder Mine. (See description No. 118.)

Indian Creek and Panwauket Group (No. 120) comprises 10 claims, 913 acres in Sec. 23, 25, 26, 27, T. 32 N., R. 9 W., held by Dr. D. B. Fields of Weaverville. It is reached by seven miles of dirt road turning from the State highway at Douglas City. Equipment includes ditch of 3000 miner's inches capacity with water available during winter months, and as late as July in years of fairly abundant precipitation; also pipe, giants, and a number of buildings. Some extension of the ditch, say two miles, will be needed to reach the larger areas of gravel. During recent years Wm. Gribble and Milford Gribble have leased the property and have worked it on a small scale.

According to the late Pierre Bouery, who operated the La Grange hydraulic mine for 15 years, when it was running on a very large scale, the water from this property should be taken to the Douglas City group (which see), which is the more important of the two.

At Indian Creek, stream gravels in terraces above the creek have been mined for depths as great as 30 feet. They rest on a bedrock of sedimentary origin, sandstones and some conglomerate beds with an appearance very similar to that of the stream gravels, but cemented to some extent. No doubt, much of the stream gravel is derived from these beds of older conglomerate. These probably belong to the Horsetown formation (Cretaceous), but some Tertiary beds may be present also.

Bibl: State Mineralogist's Reports XIV, p. 907; XXII, p. 38.

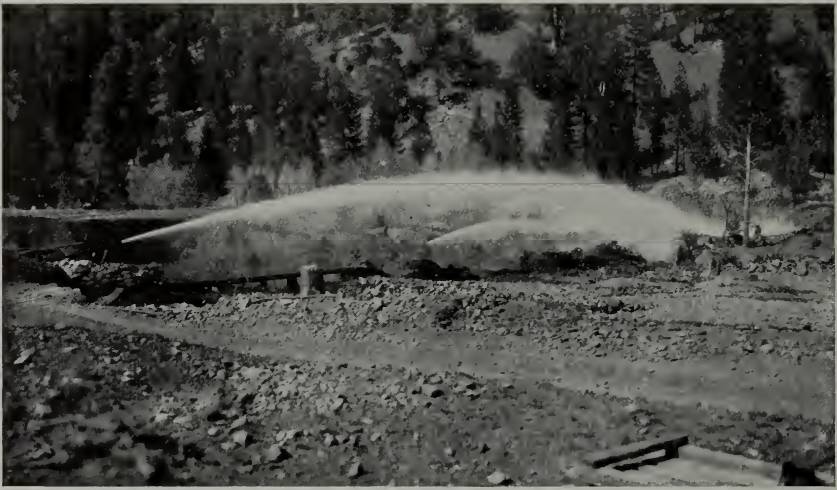

FIG. 13. Indian Creek placer. (See description No. 120.)

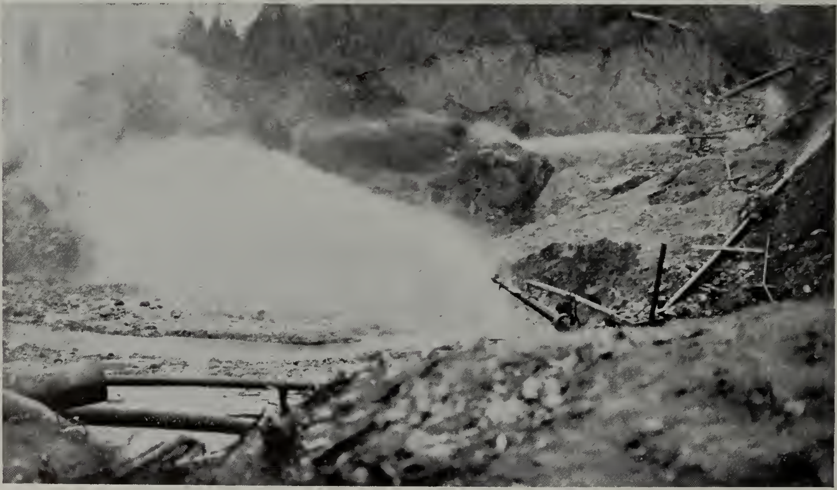

FIG. 14. La Grange Mine. Small pit on upper rim, worked in 1929. See description No. 121.)

La Grange Placer Mines, Ltd., (No. 121), a Delaware corporation, is a new company that has recently acquired the large property of the La Grange mine west of Weaverville. Thousands of acres are held in Sec. 3, 4, 9, T. 33 N., R. 10 W., and on Musser Hill to the northeast;

also water rights on Stuart Fork of Trinity River and various other streams between there and the mine. The large-scale operations at this mine have been described in State Mineralogist's Report XXII, chapter for January, 1926, copies of which are available at offices of this division, and in the other references listed below. The 11 miles of flume that brought water from Stuart Fork must be rebuilt and the additional 18 miles of ditch must be extensively repaired before the mine can be operated on the former scale. Much new equipment will be required also. A small amount of hydraulicking on the high rim of the old pit has recently been done with water brought by pipe-line from West Weaver Creek, by Milan Senger of Weaverville. Dr. Lyman Stookey of Los Angeles is president of the company, and Byron Stookey is secretary.

Bibl: State Mineralogist's Reports VIII, p. 638; X, p. 702; XII, p. 311; XIII, pp. 452–53; XIV, p. 908; XVIII, p. 257; XX, p. 182; XXII, pp. 39–42; Bull. 92, p. 94.

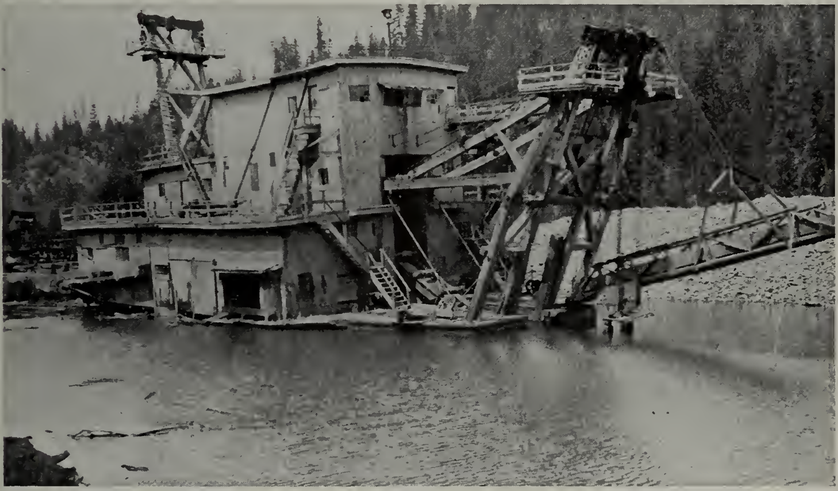

FIG. 15. Lewiston Dredge, partially dismantled. Bucket-line and stacker on ground behind. (See description No. 122.)

Lewiston Dredge (No. 122) (Placer Development, Ltd.; Lewiston Dredging Co.; Metals Exploration Co.) was shut down and partially dismantled in 1932, the stacker and bucket-line being removed and taken ashore. Its operations have been described by Lawrence K. Requa in a publication of the U. S. Bureau of Mines.[10] The dredge operated on a property of 500 acres of patented land, extending for about three miles along the main Trinity River and Stuarts Fork. The location is nine miles north of Lewiston or 50 miles from Redding, the nearest railroad point. To the end of 1931, approximately 10,000,000 cubic yards of gravel had been dredged.

The property was sampled in three stages by different owners, 100, 60, and 27 churn-drill holes being put down respectively, and a few shafts in addition. Drilling was done with a steam-driven portable rig (Keystone), and the last drilling, done in 1928, cost $7.23 per foot, including the salary of the engineer in charge. The cost of a string of new drill-pipe, which was not worn out, was charged to this drilling also. Due to difficulty of cleaning hard bed-rock, recovery from this last area sampled was 62% of the estimated value.

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[10] Requa, L. K., Description of the Property and Operations at the Lewiston Dredge, Lewiston, Calif., U. S. Bureau of Mines Information Circular 6660, November, 1932.

The hull of this dredge is 100 ft. long, 43 ft. wide, and 9 ft. deep, and the draft is 8 ft. The deck overhangs the hull 4 ft. on either side. The digging ladder carries 72 buckets of 7-cubic-foot capacity each, and is capable of digging 38 ft. below water level, and of reaching a 15-ft. bank above water-line, making a total digging depth of 53 ft. This is driven by a 150-hp. motor, to which the ladder-hoist is connected also, with provision for independent operation. A 25-hp. motor drives an 8-drum winch. Four motors on pumps range in power from 5 to 75-hp. The 32-inch stacker belt is driven by a 30-hp. motor, and the revolving screen by a 25-hp. motor. Power is furnished from lines of the Pacific Gas and Electric Co. at an average cost of 0.89 cent per kwh., and the consumption per cubic yard of gravel dug is 1.65 kwh.

The dredge was operated three shifts per day with a total crew of 15 or 16 men including the superintendent. Wages in the latter part of 1931 varied from $4.25 per day for oilers to $5.50 for winchmen and $6.00 for the blacksmith. Costs per cubic yard were as follows:

Period covered: Jan. 1, 1929, to Oct. 1, 1931.
Cubic yards handled: 2,982,204.
Total operating cost for period: $241,396.29.
Cost per cubic yard (33 months): $0.0809.

The cost for the first 19 months was $0.0840, whereas the cost for the last seven months has been $0.0652. The principal reasons for the variation in costs were: (1) Certain physical difficulties in dredging during the early period; (2) several extensive repairs necessary in early period; (3) lower commodity prices during latter period. For the year, 1929, the cost per cu. yd. was $0.0797, which was segregated as follows:

Labor	$0.0255
Superintendency	.0033
Supplies	.0325
Power	.0137
Office expense	.0003
Insurance	.0032
Taxes	.0012
	$0.0797

Lorenz Brothers Hydraulic Mine (No. 123) of five claims is now the property of Trinity County Bank of Weaverville. It is in Sec. 18, 19, T. 33 N., R. 9 W. and Sec. 13, T. 33 N., R. 10 W. During the past season, it has been operated under lease by Paul Finney, Almon Stribling, John Fratus and Harvey Finney, on two eight-hour shifts per day. The water-season usually ends in April or May. The deposit is a reconcentration of the older gravels of the Weaverville Basin by the waters of Weaver Creek. The geology of this basin has been described by J. S. Diller in publications of the U. S. Geological Survey listed below. The gravels of the Weaverville Basin and those of the La Grange mine are thought to be Tertiary in age, and to have contributed much of the gold to the gravels of the present streams in the vicinity. At the Lorenz mine, no low ground is available for dumping tailings, and gravel is elevated to the high end of the sluice with one giant, while a second giant is used for stacking tailings.

Bibl: State Mineralogist's Reports XVIII, pp. 97, 207, 257; XIX, p. 139; XX, p. 182; Pre. Rep. 8, p. 17; Bull. 92, pp. 94–95. U. S. Geol. Survey Bull. 430, pp. 51–56; Bull. 470, pp. 16–18; Bull. 540 A, pp. 5–15.

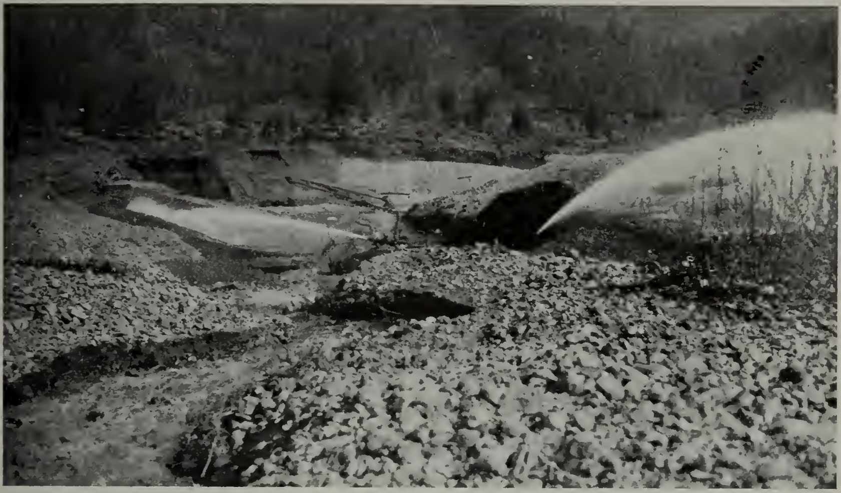

FIG. 16. Lorenz Hydraulic Mine. (See description No. 123.)

Lost Channel, see Russell.

Lucky Spot (No. 124) is a patented quarter section, NE$\frac{1}{4}$ Sec. 9, T. 33 N., R. 2 W., a mile northwest of Ingot, owned by E. C. Frisbie and others of Redding. An ancient channel is buried with a maximum of 100 ft. of overburden, and has been followed entirely through a hill with an incline, 700 ft. in length. Coarse gold has been produced by various lessees in pieces as large as four ounces. The gold is associated with a white, sticky clay, and presents a rather difficult washing problem. The property was not visited during the present survey, and information on it was furnished by Frisbie and by Frank Gelhaus of Redding, who has been figuring on a lease.

Majestic Mines Co., (No. 125) in 1931, held leases and options on the property of *Humboldt Placer Mining Co.,* about 5000 acres, Buckeye property, 1000 acres, and the Pacific property of about 4000 acres in T. 34 N., R. 8 W., T. 34 N., R. 9 W. and T. 35 N., R. 9 W., covering the Buckeye Ridge between Stuart Fork of Trinity River and Rush Creek. Home office of the Majestic company is at 86 Washington St., Boston, Mass. Phineas Hubbard is president, and A. M. Cripps, secretary.

When the property was visited in the summer of 1931, a crew of 25 men was at work under the supervision of W. D. Ball. A tractor and grader were being used to construct a road along the old Buckeye ditch in Sec. 29 and 33, T. 35 N., R. 9 W. so that lumber could be transported for the building of flumes. About two miles of the road had been finished. The Buckeye ditch is a very old ditch, about 30 miles long, on the opposite side of Stuart Fork from the La Grange ditch. Some prospecting was under way in Baker Gulch near the SW. corner of T. 34 N., R. 8 W. in gravel that probably had been reconcentrated by the present stream from the lower grade gravels of the main Buckeye Ridge. Prospecting had been done on the Stuarts Fork side of the ridge during the preceding winter also. A little later in the year all of this work was discontinued. W. D. Ball was reported to have a small crew at work surveying on Buckeye ground in the summer of 1932.

Bibl: (Buckeye and Humboldt) State Mineralogist's Reports XIV, p. 912; XXII, pp. 37-38. U. S. Geol. Survey Bull. 540, p. 18.

Meckel Property (No. 126) on West Weaver Creek, 2½ miles northwest of Weaverville, is owned by A. C. Meckel of Weaverville, and has been leased during the past season to Manuel Maurica and Frank Lopez.

Phillips, see Big Bend.

Pine Tree, see Upham.

Reddings Creek Placer, Ltd. (No. 127), has acquired the Wallace Bros. mine in Sec. 33, T. 32 N., R. 9 W., and has been operating it during the past two seasons. The company has offices in the Finance Building, San Francisco, and at 139 N. Virginia Street, Reno, Nevada. Sam Garfalo is secretary and F. C. Wilkins is president and general manager.

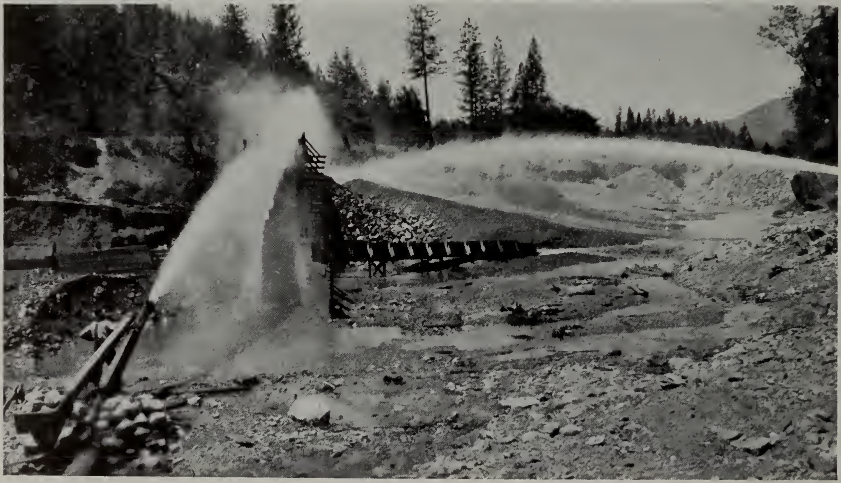

FIG. 17. Reddings Creek Hydraulic Mine. (See description No. 127.)

During the season, 1930-31, an old ditch giving about 100 ft. of head was in use. With this a piece of ground roughly estimated at 900 ft. long, 150 ft. wide and 8 ft. deep, was mined with a total recovery stated to have been $4,000. Tailings must be stacked with a giant, as no low ground is available for a dump.

Installation of new equipment was completed in April, 1931. This included a 20-ft. dam, 2½ miles of flume, 4 ft. wide and 3 ft. deep, a 30-inch syphon, 300 ft. long of 20-inch for 2000 ft., and two 15-inch lines, each 1000 ft. long to the mine. Available head is 300 ft. This new equipment is stated to have cost $40,000. Another item was a tailings stacker consisting of an inclined grizzly. A giant forces the gravel up this grizzly, and oversize is discharged at the upper end. Undersize drops between the inclined bars and is treated in an attached sluice containing riffles. The outfit is pulled ahead with a 30-hp. tractor every few weeks as required to keep it close to the portion of the gravel being mined.

The mine has been operated continuously during the past water season, ending about July 1, 1932. Four giants were in service, but water supply is sufficient for only two of these at one time. The giants are No. 3 with 3-inch nozzle and No. 4 with 5- and 6-inch nozzles. One giant mines the gravel and delivers it to the base of the stacker, a second drives it up the stacker, while a third is required to stack the fine tailings of 3-inch size and under. Eight men were employed, and piping was carried on for 14 hours per day.

The deposit consists of stream gravels of Redding Creek. Bedrock is a sedimentary series of gravels, sandstones and tuffs of Tertiary age beneath the portion of the deposit mined recently. A little farther down the stream Horsetown beds (Cretaceous) are found. Some fine fossil leaf-prints were shown to the writer by D. S. Upham of Douglas City, who had been employed at the mine, and who found them in the bedrock. The particular spot where they were found was later covered with tailings.

Bibl: State Mineralogist's Report XXII, p. 60.

Rising Sun Mine (No. 128) comprises 190 acres of unpatented mining claims in Sec. 21, 22, 26, 27, T. 34 N., R. 9 W., held by Basil Froloff of Lewiston. From Redding, it is 48 miles northwest by road, 35 miles State highway, balance good dirt road. The deposit consists of the stream gravels of Rush Creek and terrace gravels a little higher in elevation than the present stream. Depths vary from 10 to 40 ft., widths from 400 to 1200 ft.; and the length along the channel is 1¾ miles. Overburden on some of the upper terraces reaches a depth of from 2 to 10 or 15 feet. Bedrock is a decomposed granodiorite in the lower quarter mile of the property; the balance is cemented gravel alternating with beds of clay and sandstone with a dip to the northwest of 30°. Some good timber grows on the property and there is more on adjoining land.

For thirty years the upper three-quarters of a mile of this property was worked by various persons by ground sluicing. Froloff then worked 5 acres of this upper portion with a hydraulic giant and a low head of water. He states that the yield was 35¢ to 45¢ per cubic yard. During the season 1931–32, Froloff built a new ditch, half a mile long, on the lower part of the property with a capacity of about 500 miner's inches, and giving a head on the gravels near the elevation of the present stream of from 20 to 40 feet. Other equipment includes 600 ft. of 15-inch pipe and two No. 3 giants using 4-, 5-, or 6-inch nozzles. From 2000 cubic yards that he mined with this equipment, where he was unable to reach bedrock, Froloff states that he recovered $160. In another part of the pit, where he reached bedrock, $27 is stated to have been recovered from 30 or 35 yards. This work indicates that there is an old channel roughly paralleling the present one, but breaking into it here and there. Wm. Carr has a property of 60 acres adjoining at the mouth of Baxter and China gulches.

Russell Mine (No. 129) (Lost Channel Mine) lies immediately south of the Clear Creek drainage in the Igo mining district, Sec. 34, T. 31 N., R. 6 W., and Sec. 4, T. 30 N., R. 6 W., 12 miles southwest of Redding, at an elevation of 1100 feet. The deposit is probably a section of an ancient wash of Clear Creek, and has a width of from half a mile to a mile. F. H. Russell of Redding holds 210 acres patented and additional mining locations to make a total of 500 acres. The present drainage of Upper Dry Creek passes directly across the course of the old channel in a southwesterly direction.

Prospecting of the ground by means of 12 shafts and about 38 drillholes is stated by Russell to have indicated an average value per cubic yard of 10⅓ cents for an average depth of 45 feet. The depth to bedrock varied from 18 to 80 feet. Bedrock is largely quartz diorite, in some places decomposed; but a sandstone bedrock is found on the southern part of the holdings.

From the old Dunham tunnel, half of a block of ground 200 by 725 ft. has been removed. The other half still stands in the form of pillars; and the workings are largely open, with a height of from 8 to 10 feet. Samples taken from the pillars are stated to indicate that the gravel removed yielded $60,000. Good pannings can be obtained from certain parts of these workings at the present time. During the season when water was available in 1931–32, Russell and one other man drifted on the gravel at bedrock from a point on Dry Creek about half a mile north of the Dunham tunnel. Some coarse gold was produced from this work, nuggets worth $2 and $3 each.

Bibl: State Mineralogist's Reports XIV, p. 791; XVIII, p. 599; XXII, pp. 186–87.

Steiner Flat (No. 130) is a gravel deposit at the junction of Trinity River and Dutton Creek, three miles down the river from Douglas City. W. D. and G. C. Lorenz of Weaverville holds 180 acres in Sec. 35, 36, T. 33 N., R. 10 W. Hydraulicking on a small scale was done here during the season 1931–32 by W. D. Lorenz. Water supply from the present system lasts only a short time after the winter storms are over.

Bibl: State Mineralogist's Report XIV, p. 914.

Trinity Dredging Company (No. 131) has operated a dredge for many years in Sec. 5, 6, 7, and others, T. 33 and 34 N., R. 8 W., four miles north of Lewiston. Miss Mary Smith of Lewiston is president, and Chas. R. Harris is dredge master. The bucket-line of this dredge carries 42 buckets of 11-cubic-foot capacity and 42 links of the same length as a bucket. When the bucket-line is heavily loaded, these links carry about 2 cu. ft. each. Nine buckets are dumped per minute.

Gravel is washed in a trommel with 6- and 8-inch holes. Oversize, up to 4 ft. in diameter, is dumped over the side through chutes. Undersize goes through the holes in the trommel to a sluice 125 ft. long, 4 ft. wide and 2 ft. deep. The lower part of the sluice, 110 ft. long, is carried on a scow to the rear of the dredge. Separate drums are provided on the winch to swing the sluice for proper distribution of tailings, which are deposited so that the surface is left nearly level. Riffles are made from 2- by 3-inch steel angles with 2-in. face up and 3-in. face vertical. Spacing between angles is 2 inches. The tops are protected with manganese-steel castings, one inch thick, made with bars two inches wide alternating with two-inch openings. These castings are in sections 4 ft. square. Some of these assembled riffle sections, 4 ft. square, are placed with the bars lengthwise of the sluice; but most of them are placed crosswise. The hull of the dredge is 110 ft. long, 50 ft. wide and 7 ft. deep, and draws about 5½ ft. of water. It is provided with two steel spuds of 25 tons each.

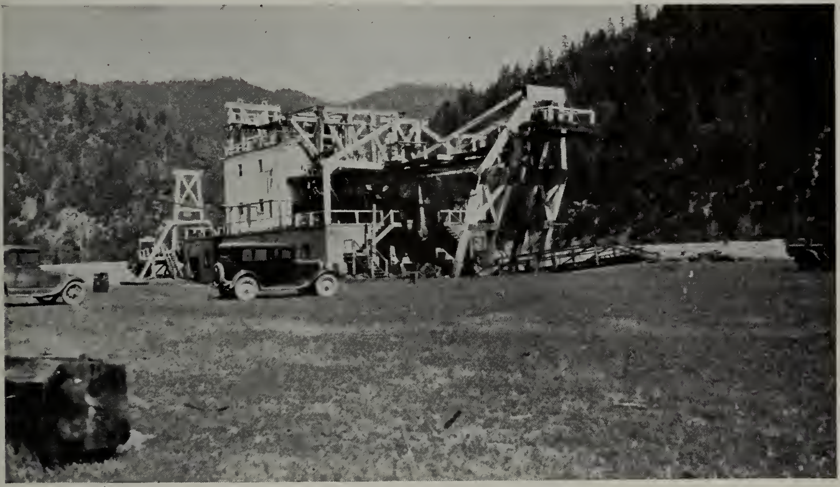

FIG. 18. Trinity Dredge. (See description No. 131.)

List of motors, all taking power from the lines of the Pacific Gas and Electric Co. at 2200 volts follows: 150-hp. digging motor, geared to line with herringbone gears, no belt, 52-hp. winch motor, driving 10-drum winch, 100-hp. on 16-inch centrifugal pump, 50-hp. on 10-in. centrifugal pump, 35-hp. on 6-in. centrifugal pump, 25-hp. on trommel, 25-hp. on compressor and other shop tools, 50-hp. on a shore pump needed at times to keep the pond full of water.

Bibl: State Mineralogist's Reports XIV, p. 919; XVIII, pp. 601, 734–35; XXII, p. 59, 62; Prelim. Rep. No. 8, p. 18; Bull. 36, p. 104; Bull. 92, p. 95. U. S. G. S. Bull. 540, p. 20.

Trinity Exploration Co., see Hook and Ladder.

Trinity Farm and Cattle Co. (No. 132), c/o Wm. Foster, Trinity Center, owns some 2000 acres of land on the Trinity River near the center of T. 36 N., R. 7 W., much of which is possible dredging ground. Some drilling to test its possibilities for dredging has recently been done, but the job was not completed, and the results from the holes drilled are not known to the writer.

Trinity River Mining Co. (No. 133), 814 First National Bank Building, Oakland, owns 340 acres on Trinity River in Sec. 5, 8, T. 33 N., R. 8 W., two miles north of Lewiston. A tunnel, 1385 ft. in length, was constructed, giving a head of 25 ft., which was utilized in a turbine and centrifugal pump to force water into pipes for hydraulic mining. This work was done some years ago and the property has been idle for years, but has received some attention recently as a possible source of power to work nearby mines.

Bibl: State Mineralogist's Reports X, p. 709; XII, p. 314; XIII, p. 465; XIV, pp. 915–16. U. S. G. S. Bull. 540, p. 20.

Upham Hydraulic Mine (No. 134) (Pine Tree) consists of 80 acres of patented land and 40 acres of placer claims in Sec. 29, 30, T. 32 N., R. 8 W., owned by F. L. Upham and S. E. Upham of Douglas City. According to F. L. Upham, 50 acres of this is gravel, which his operations indicate will yield 20¢ to 30¢ per cubic yard in gold. His operations indicate a depth of gravel of about 24 ft., and some of it is covered with several feet of overburden consisting of angular slide-rock and soil from the hillside above. The deposit is on three terraces or upper channels of the North Fork of Indian Creek, varying from 15 to 50 ft. higher in elevation than the present stream. Upham has worked out 1000 cubic yards from one pit and 8000 cu. yd. from another, with water from a ditch 45 ft. higher in elevation than the second terrace above the present stream. Bedrock is a hard hornblende schist that has a tendency to form natural riffles across the direction of flow of the earlier stream. A quartz vein about five feet wide is exposed in this bedrock in one of the pits, and it is stated to carry a little gold.

Capacity of present siphons across the creek is 700 miner's inches. Other equipment consists of 1200 ft. of pipe varying in size from 11 to 24 inches, three giants, one each No. 1, 3 and 4. Upham states that a better water supply and a better head could be obtained by building 3000 ft. of flume. The head would be 150 ft. and 2000 miner's inches of water would be available for six months of the year.

Vergnes Property (No. 135). Chester and Henry Vergnes of Oak Bottom (Schilling P. O.) hold 1178 acres in Sec. 7 and 17, T. 32 N., R. 6 W., along Clear Creek. Sec. 17 has recently been purchased from the railroad. The creek flows for a distance of a mile through Sec. 7 and three-quarters of a mile through Sec. 17. Part of the land in Sec. 7 is used for ranch purposes, but is underlain by gravels. On Sec. 17 there are bars of gravel along the creek, roughly 50 or 100 ft. wide and a few hundred feet long. Most of these have already been worked by small-scale placer miners, but according to Henry Vergnes, the gravel still contains fine gold and valuable black sands. There are a few old, caved cuts on quartz stringers on this section also.

On Sec. 7, four different placer operations were recently noted in various stages of development as follows: On a part of the section recently purchased by J. J. Hammer, a very small power shovel, gasoline driven, with a sluice attached to the shovel, had recently done some digging in the bed of the creek. Results had been unsatisfactory, and the shovel was idle at time of visit.

On another part of the ground, a meadow, a shaft had been sunk to bedrock, and a bin and washing machinery were being installed by Chester Vergnes and F. E. Brewster. A 6-inch centrifugal pump was in place at the collar of the shaft, a bin for the gravel, and washing machinery consisting of vibrating screens, sluice, revolving drum with perforations for black sands, and a belt concentrator for treating these. Gravel is to be dumped from cars at the bottom of the shaft into a boot, from which a bucket-elevator is to raise it to the bin. Bucket-elevator had not yet been installed at time of visit.

On another part of the property, Art Affleck, Harry Crites and Roy Kerr had started to mine gravel with drag-line excavators operated by two Fordson tractors. Washing was to be done with water pumped from the creek. At time of visit, repairs were being made to pumps.

On 61 acres of this property purchased from Vergnes Bros. by J. J. Hammer, at the confluence of Boulder Cr. and Clear Cr., Hammer is working the bed of Clear Cr. by hand. He states that it has already been worked, and that what he recovers is mostly surface-wash that has been brought down by recent flood waters. He also occasionally finds gold in crevices in the bedrock.

Wallace Bros., see Reddings Creek Placer, Ltd.

GEOLOGIC BRANCH

CURRENT NOTES

Olaf P. Jenkins, Chief Geologist

Since Mining in California is now including the publishing of reports on geology, which represent activity on the part of the Geologic Branch, the name of the quarterly has seemed inadequate. Therefore, the name has been changed to the more appropriate California Journal of Mines and Geology.

Since the greatest activity in mineral production today lies in gold mining, the Division of Mines has undertaken an intensive study of its recent development. In this issue of the quarterly chapter, the gold deposits of the Weaverville and Redding quadrangles are described in detail by Chas. V. Averill, District Engineer, in conjunction with a geological study made by N. E. A. Hinds, who has for several years been mapping this region, especially in the Weaverville quadrangle. The geologic map presented at this time, though not the final product, shows clearly the areal extent of the formations in both the Weaverville and Redding quadrangles, and also in a part of the Red Bluff quadrangle. In compliance to a special request of the Division, Dr. Hinds has prepared an advance report describing the formations occurring in the area. This map, together with the recently published geologic maps of the adjoining Shasta quadrangle to the north, and the Sierra Nevada region to the southeast, presents a broad picture of the great gold-mining regions of California.

The northwesternmost section of the State, Del Norte and Siskiyou counties, have been heretofore nearly neglected by geologists, so that the following report by John Maxson on a part of this region fills a long-felt need, especially in that he describes the mineral deposits and their relationship to the geology. His paper is entirely a contribution and it is certainly gratifying to know that he intends to continue his studies in the adjoining, even more inaccessible areas.

That there are numerous ways in which geology can be useful to civil engineering has been demonstrated many times, especially in California. At the suggestion of the Geologic Branch, Douglas Clark has prepared a paper on ''Some Applications of Geology to Civil Engineering Projects.'' This also is entirely a contribution on the part of its author.

Lakes, whether natural or artificial, constitute a very important natural resource to California. Their origin, formation and destruction involve features of considerable geologic significance. The very fundamentals of the science are involved in their study, and no one should be better able to discuss a topic on lakes than William Morris Davis, the veteran physiographic-geologist. ''The Lakes of California,'' a generous contribution of its author, published in this issue of the Journal, grew out of a special study of Clear Lake, and it was the pleasure and satisfaction of the Chief Geologist to have accompanied the author of this report on several extremely instructive excursions. The material presented should be of special interest to students of water-supply, engineering, and physiography, as well as instructive to pleasure seekers of lake resorts.

One of the projects of the Geologic Branch, is the mapping of the geology along the eastern front of the Sierra Nevada, especially in Mono and Madera counties. A by-product of this investigation was the discovery of a deposit of a rare mineral known as *piedmontite,* which is described in detail by Evans B. Mayo, temporary field geologist of the Geologic Branch.

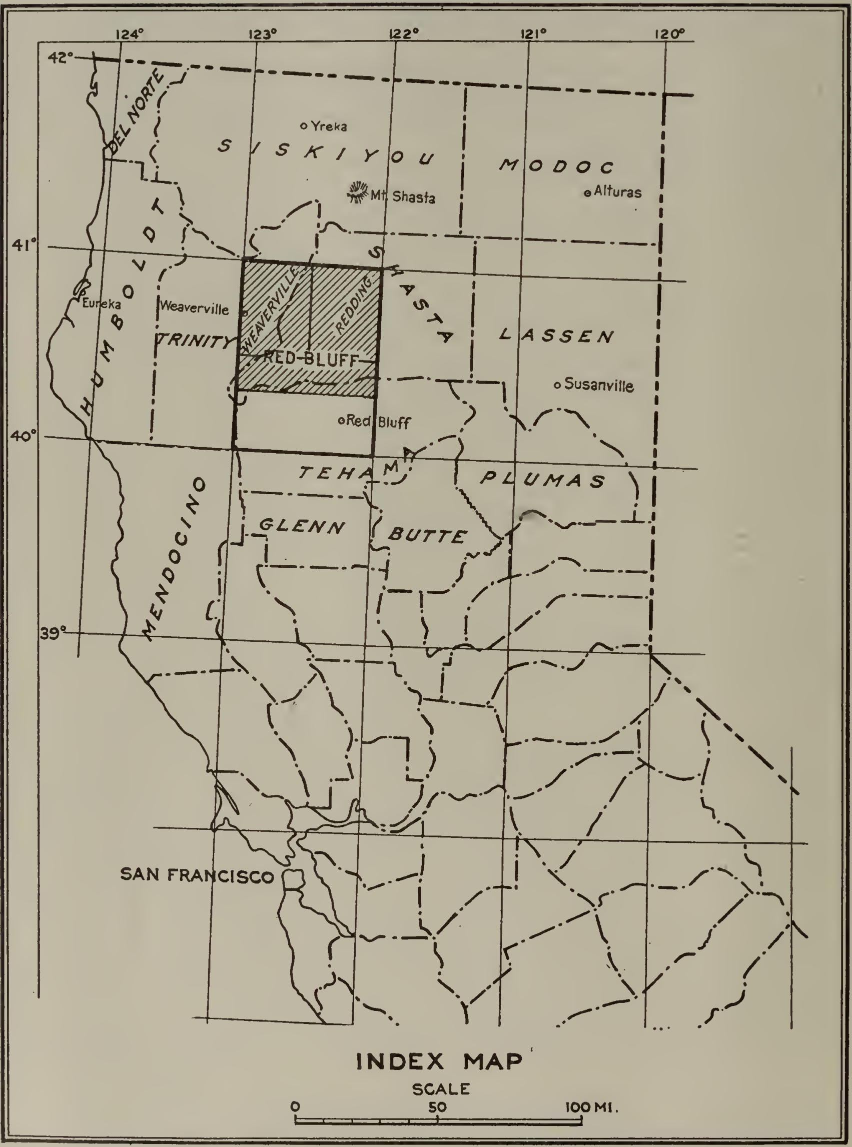
124°
123°
122°
121°
120°
42°
41°
40°
39°
DEL NORTE
SISKIYOU
Yreka
Mt Shasta
MODOC
Alturas
HUMBOLDT
Eureka
Weaverville
TRINITY
WEAVERVILLE
REDDING
RED-BLUFF
SHASTA
LASSEN
Susanville
Red Bluff
TEHAMA
PLUMAS
MENDOCINO
GLENN
BUTTE
SAN FRANCISCO
INDEX MAP
SCALE
0
50
100 MI.

FIG. 1. Index map of northern California showing area covered in report.

GEOLOGIC FORMATIONS OF THE REDDING-WEAVERVILLE DISTRICTS, NORTHERN CALIFORNIA

By Norman E. A. Hinds *

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INTRODUCTION

General Statement

At the request of the State Mineralogist and the Chief Geologist of the Division of Mines, the writer has submitted the following report

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* Associate Professor of Geology, University of California.

describing briefly the geological formations represented on the accompanying map (Plate 1) which includes the Redding and Weaverville quadrangles and the northwestern part of the Red Bluff quadrangle of northern California. The recently developed renewal of activity in gold mining makes such a statement especially desirable at the present time. A report on the mines of the district by C. V. Averill, District Engineer of the Division of Mines, is published with this paper.

As shown on the accompanying index map (Fig. 1), the quadrangles above mentioned lie in Shasta and Trinity counties of northern California and include a section of the southern Klamath Mountains, adjacent parts of the Cascade lava beds, and the northern end of the Sacramento Valley. The Redding district comprises the southeastern section of the Klamath ranges which are bordered on the east and southeast by the lava covered area of northeastern Shasta and Modoc counties generally included in the Cascade province and on the south by the northern end of Sacramento Valley. The Weaverville quadrangle lies wholly within the southern Klamath Mountains. The mapped section of the Red Bluff quadrangle includes the southern foothills of the Klamath ranges and adjacent part of the northern Sacramento Valley.

This report is essentially a field handbook dealing primarily with the lithologic character and distribution of the various geological formations exposed in the areas mentioned and is in no sense a complete geological report. The petrographic characters of the principal igneous rocks are briefly noted, but descriptions of the many variants to be found in the various igneous bodies or formations lie beyond the scope of this paper. The petrography of the sediments and most of the metamorphic rocks is omitted. In like manner only the major structural features are considered. For further information regarding the geology and structure of the Redding quadrangle, the reader is referred to the Redding Folio, by J. S. Diller, published in 1906 as No. 138 of the United States Geological Survey, Atlas of the United States. A number of short papers dealing with the geology and ore deposits of the Redding and Weaverville districts are listed in the accompanying bibliography. The writer plans to publish a preliminary report on the geology of the Weaverville district in a succeeding number of the CALIFORNIA JOURNAL OF MINES AND GEOLOGY and at some later date a still more detailed report.

The Geologic Formations

A tabular summary of the geological formations exposed in the three principal sections of the area mapped is given below:

	Redding quadrangle	*Weaverville quadrangle*	*Northwestern part of Red Bluff quadrangle*
Recent	Alluvium	Alluvium	Alluvium
Pleistocene	Red Bluff gravels	Klamath gravels	Klamath gravels
	Lava flows	---------------	---------------
Pliocene	Lava flows	---------------	---------------
	Tehama and Tuscan formations	---------------	---------------
Eocene	Montgomery Creek formation	Weaverville formation	---------------
Cretaceous	Chico formation	---------------	---------------
	---------------	Shasta series	Shasta series
Jurassic	---------------	---------------	Knoxville formation (?)
	Late Jurassic intrusive igneous rocks	Late Jurassic intrusive igneous rocks	Late Jurassic intrusive igneous rocks
	Potem formation	---------------	---------------
	Bagley andesite	---------------	---------------
	Modin formation	---------------	---------------
Triassic	Brock shale	---------------	---------------
	Hosselkus limestone	---------------	---------------
	Pit formation	---------------	---------------
	Dekkas andesite	---------------	---------------
Permian	Nosoni formation	---------------	---------------
	Dekkas andesite	---------------	---------------
Carboniferous Mississippian	Baird formation	---------------	---------------
	Bragdon formation	Bragdon formation	Bragdon formation
	Bass Mountain basalt	---------------	---------------
Devonian	Kennett formation	---------------	---------------
Pre-Middle Devonian	Copley meta-andesite	Copley meta-andesite	Copley meta-andesite
	---------------	Chanchelulla formation	Chanchelulla formation
	---------------	Salmon schist	Salmon schist
	---------------	Abrams schist	Abrams schist
Age unknown	Serpentine	Serpentine	Serpentine
Late Paleozoic	---------------	Intrusive igneous rocks	Intrusive igneous rocks

Published Reports

The chief papers describing the geological formations of the mapped area are listed below:

Diller, J. S., The Redding Folio, U. S. Geol. Surv., No. 138, 1906.

The Auriferous Gravels of the Trinity River Basin, California, U. S. Geol. Surv., Bull. 470, pp. 11–29, 1911.

Klamath Mountain Section, Amer. Jour. Sci., 4th series, vol. 15, pp. 342–362, 1903.

Auriferous gravels of the Weaverville quadrangle, California, U. S. Geol. Surv., Bull. 540, pp. 11–21, 1914.

Diller, J. S., and Schuchert, C., Notes on Some Localities of Mesozoic and Paleozoic in Shasta County, California, Amer. Jour. Sci., vol. 47, p. 416, 1894.

Ferguson, H. S., Gold Lodes of the Weaverville quadrangle, California, U. S. Geol. Surv., Bull. 540, pp. 22–79, 1910.

Graton, L. C., The Copper Deposits of Shasta County, California, U. S. Geol. Surv., Bull. 430, pp. 71–111, 1910.

Hershey, O. H., The Metamorphic Formations of Northwestern California, Amer. Geol., Vol. 27, pp. 226–230, 1901.

Hinds, N. E. A., Paleozoic Eruptive Rocks of the Southern Klamath Mountains, California, Univ. of Calif. Publ., Bull. Dept. Geol. Sci., vol. 20, pp. 375–410, 1932.

Smith, J. P., The Metamorphic Series of Shasta County, California, Jour. Geol., vol. 2, pp. 588–612, 1894.

The Geologic Map

The geologic map which this report describes is a composite of the Redding and Weaverville quadrangles and northwestern part of the Red Bluff quadrangle. The Weaverville area was mapped by the writer between 1925 and 1930. A sketch map of a part of the quadrangle, accompanies a report on the gold lodes by H. G. Ferguson [1] published in 1914. In the northwestern part of the Red Bluff quadrangle the contacts of the formations of the Subjacent Series (formations involved in the late Jurassic deformation) were mapped by the writer, those of the superjacent Cretaceous strata (not affected by the late Jurassic deformation) by R. Dana Russell, the writer's associate in the Klamath Mountains investigation from 1928–30. The contacts in this area were mapped on township plots since the topographic sheet long ago published by the U. S. Geological Survey on the scale of 1:250,000 is highly inaccurate and of little use in the field. The township plots are little better; nevertheless it seemed advisable to extend the Weaverville contacts southward to the margin of the superjacent Cretaceous blanket. The area mapped in the Red Bluff quadrangle for the most part lies north of the highway extending from Redding to Platina or Noble Station. The contacts on the Redding section are taken with some modifications from the map by J. S. Diller [2]. The stratigraphic determinations and the nature of certain igneous bodies are based on the most recent geologic and paleontologic work done in the area and differ in a number of respects from Diller's findings, as the following statement indicates:

CORRELATION CHART

Redding Folio by J. S. Diller U. S. Geol. Surv., Atlas Folio 138, 1906	Revised map of Redding quadrangle by N. E. A. Hinds and R. Dana Russell
Pre-Kennett Middle Devonian Balaklala rhyolite	Late Jurassic Chonolith of granite (alaskite) porphyry
Carboniferous Pennsylvanian McCloud limestone	Permian McCloud limestone (lowest Permian)
Nosoni formation	Nosoni formation (upper Lower or lower Middle Permian)
Triassic Pre-Hosselkus Upper Triassic Bully Hill rhyolite	Late Jurassic Chonolith of granite porphyry
Miocene Ione formation	Eocene In part Montgomery Creek formation Pliocene In part Tuscan formation
Pliocene Tuscan formation	Pliocene Tuscan formation Tehama formation
Pleistocene Red Bluff gravels	Pleistocene Part of Red Bluff as mapped by Diller is Tehama formation

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[1] Ferguson, H. G., Gold Lodes of the Weaverville Quadrangle, California U. S. Geol. Surv. Bull. 540, pp. 22-79, 1914.

[2] Diller, J. S., The Redding Folio: Geologic Atlas of the United States Folio 138, 1906.

DESCRIPTION OF THE GEOLOGIC FORMATIONS

The descriptions of the Salmon and Chanchelulla formations, the Copley meta-andesite, the Bass Mountain diabase, the Baird tuffs, and the Nosoni formation are taken with modifications and additions from an earlier paper by the writer [3].

THE SUBJACENT FORMATIONS

Pre-Middle Devonian. (Probably pre-Silurian.)

The Siskiyou Terrane.

Abrams schist.

The Abrams schist was originally described by Hershey [4], during his study in the Klamath and Siskiyou ranges and was named from exposures near Abrams Post Office on Coffee Creek in northern Trinity County. In the western part of the Weaverville quadrangle and the adjacent section of the Red Bluff quadrangle this formation occupies large areas. The principal exposures extend from the Cretaceous overlap northward almost to the town of Weaverville where they are buried by Tertiary beds. A second, small area lying east of and closely related to the first, extends from Mikes Peak in the south central part of the Weaverville quadrangle southward to the north slope of Bully Choop Mountain. A third area occupies the southern slope of Joes Peak just to the east of the area last described. A fourth area of considerable extent is located along the eastern side of the canyon of the Stuarts Fork of the Trinity River from near the mouth of Van Matre Creek northward into the adjacent Shasta quadrangle. In all of these areas the strata are dipping steeply, and in the first mentioned area at least are isoclinally folded so that repetition of the beds occurs.

The Abrams formation consists for the most part of highly micaceous, white, pale gray, or dark gray schists, generally pink or red on weathered surfaces, and composed of colorless or black mica and varying amounts of quartz. In places the mica is green and gives to the rocks a blue-green or dark green color. These schists apparently were derived from clays and shales, much of which contained more or less quartz, and from shaly sandstones. In places the schists grade into micaceous quartz schist with a decrease in the proportion of mica and increase in proportion of quartz. These rocks in turn are transitional into micaceous quartzites and pure quartzites, which were originally slightly impure sandstones and almost pure quartz sandstones respectively. The volume of micaceous quartz schists, micaceous quartzites, and quartzites is small compared to that of the dominant mica schists. A few beds of highly metamorphosed conglomerate and numerous lenses of coarsely crystalline limestone and more finely crystalline marble are present. Along the Stuarts Fork of the Trinity River are considerable thicknesses of rapidly alternating layers of quartzite and mica schist apparently derived from alternating thin beds of chert and clay. Hornblende schists in zones ranging from a few inches to several hundred feet in thickness are present at many horizons in the Abrams;

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[3] Hinds, N. E. A., Paleozoic Eruptive Rocks of the Southern Klamath Mountains: Univ. Calif. Publ., Bull. Dept. Geol. Sci., vol. 20, pp. 375-410, 1932.

[4] Hershey, O. H., Metamorphic Formations of Northwestern California, Am. Geol. vol. 27, pp. 226-230, 1901.

the contacts of some of the zones are concordant while others transgress the original bedding of Abrams sediments. These hornblende schists probably represent intrusive phases of the Salmon volcanic activity which followed deposition of the Abrams sediments, though of course some may represent contemporaneous flow of basalt or andesite.

In the great area of the southern Weaverville quadrangle the reddish micaceous schists constitute the great bulk of the exposures; in the area along the Stuarts Fork of the Trinity River the section is considerably more varied, and, while mica schist is the dominant rock, micaceous quartz schist, quartzite, and the rapidly alternating series of quartzites and mica schists are an important element.

The thickness of the formation at the type locality on Coffee Creek in the Shasta quadrangle is estimated by Hershey to be 1000 feet. On the Stuarts Fork of the Trinity River in the Weaverville quadrangle, an incomplete section measures about 2500 feet. In the large area in the southern portion of the Weaverville quadrangle the thickness probably is more than 5000 feet though accurate determinations are uncertain because of the isoclinal folding.

The Abrams is the oldest sequence in the Weaverville district, and, so far as is known, in the whole of the Klamath and Siskiyou mountains. In the Weaverville area the lowermost beds are either in contact with intrusive granites of late Jurassic age or with intrusive serpentines whose exact age has not been determined. Farther to the north the relationships at the lower contact have not been described except for the statement that no older formation has been recognized. Above an erosional contact separates the Abrams from the overlying Salmon schist which is a series of highly metamorphosed basic igneous rocks.

Wherever the writer has seen the Abrams formation and in other places where it has been described, the rocks are thoroughly recrystalized so that none of the original sedimentary types remain. The schistosity in general parallels the original bedding of the sediments so that the initial metamorphism was accomplished without much deformation and probably was of the load type. Remetamorphism has taken place in certain localities as a result of later deformation or as the result of the intrusion of various types of plutonic rocks. One of the most striking zones of remetamorphism is to be found adjacent to a great stock of granodiorite which intrudes the Abrams exposed along the Stuarts Fork of the Trinity River.

Salmon Schist.

Overlying the Abrams schist with erosional unconformity is the Salmon hornblende and chlorite schist also originally described by Hershey[5] from exposures along the Salmon River. Hershey called the formation the Salmon hornblende schist, but in the Weaverville quadrangle there are notable volumes of chlorite schist as well. Hershey considered that the Salmon schist was of sedimentary origin though he later accepted a suggestion made by A. C. Lawson[6] that it probably was a series of fine water-laid volcanic ash. The igneous origin of the formation except for a few sedimentary interbeds have been recently demonstrated by the writer.[7] Two principal areas of the

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[5] Hershey, O. H., *op. cit.*
[6] Hershey, O. H., Rocks of Southern California, Am. Geol., vol. 29, p. 272, 1902.
[7] Hinds, N. E. A., *op. cit.*, pp. 388–390.

Salmon schist occur in the southern part of the Weaverville quadrangle infolded with the Abrams schist; one extends from Hazel and O'Connell Gulch southward virtually to the boundary of the quadrangle and the second is continuous from Indian Creek to the Cretaceous overlap in the north part of the Red Bluff quadrangle. A third area runs through the hilly country about two miles south of Weaverville. The main exposures extend northward from the northern margin of the Tertiary deposits in the Weaverville basin and north of Van Matre Creek are divided into two parts separated by the large tongue of the Abrams schist running along the eastern wall of the canyon of the Stuarts Fork of the Trinity River. The main portion of this area of the Salmon schist lies on the western side of the Stuarts Fork and extends into the Big Bar quadrangle which joins the Weaverville district on the west. A short tongue continues along the Stuarts Fork principally on the western side to a point between Bear Gulch and Devils Canyon. A much narrower belt lies to the east of the Abrams schist area and extends past the north border of the Weaverville quadrangle into the Shasta district. The strata are dipping at high angles in all of the areas mentioned. The greatest thickness exposed is in the area west of Stuarts Fork and probably exceeds 5000 feet though the determinations are uncertain because of complications by folding and the lack of identifiable structures through most of the thickness.

As previously noted the principal rocks of the Salmon formation are schistose and much less common gneissoid rocks derived from basic (probably basaltic and andesitic) volcanics. While various petrographic types are represented, great thicknesses and extensive areas are homogeneous in appearance and in mineralogic composition. One of the most common varieties is a grayish green, olive-green or grass-green, fine-grained, finely foliated hornblende schist generally having a silky sheen or luster. Under the hand lens acicular green hornblende, flakes or chlorite, and small lenses composed of quartz and feldspar are visible. A second exceedingly common type is coarser textured and generally dark green in color. Prismatic, highly lustrous, dark green hornblendes, chlorites, and somewhat larger lenses of quartz and feldspar are visible to the eye. Certain rocks show large hornblende individuals which may reach one centimeter in length. Coarsely banded gneissoid phases are common in certain localities. In the region about the granitoid intrusions in the mountains of western Trinity County, *lit-par-lit* injection of granitic magma into the hornblendic rocks has produced coarse gneisses. The hornblende has been recrystallized and many crystals measure from $\frac{1}{4}$ to $\frac{1}{2}$ inch in length.

The microscope shows that acicular or prismatic crystals of green hornblende compose from 60 to 90% of the hornblende schist. Plagioclase (albite to oligoclase) and quartz are the other principal constituents; the percentage of the two minerals varies, though plagioclase generally exceeds quartz in amount. In some sections quartz is scarce or absent, while plagioclase is always present. Some of the quartz-feldspar lenses are abundantly penetrated by needles of hornblende; others show only a few needles or else are quite free from them. Occasional grains of quartz and feldspar and aggregates of these minerals are present in the hornblendic bands. Epidote and ziosite are rather common associates of hornblende and chloritized biotite generally is present. Minor constituents present in varying amounts are apatite, ilmenite, and magnetite. Some sections contain practically no iron ore minerals.

The hornblende paragneisses are similar mineralogically to the schists except for their coarser foliation and the greater abundance of quartz and plagioclase.

The chlorite schists generally are deep bottle green in color though certain types exhibit a grayish green or olivine-green hue; all have a prominent silky sheen. The schists are fine-grained, highly foliated, and not infrequently rather complexly contorted. The chief visible mineral is chlorite; under a hand lens small amounts of quartz and feldspar are visible in many hand specimens. Specially fine exposures of the chlorite schist may be found in the Trinity Alps along Van Matre, Owen, Boulder, and other creeks flowing from the west into the Stuarts Fork of the Trinity River, and also west of the Middle Fork of Cottonwood Creek in the Red Bluff quadrangle.

The mineralogy of the rocks indicates that they were derived from basic lavas and probably in part from basic pyroclastics which appear to have been erupted upon a rather gently undulating plain eroded into the Abrams sediments. Apparently a great thickness of these volcanics was piled up to form a volcanic plateau of huge area, for the Salmon schist has been recognized from the Klamath Mountains of Tehama County south of the area mapped northward through the northern Klamath and Siskiyou ranges of California and Oregon, a distance of about 200 miles; regarding the east-west extent little is known. The presence of quartzites, micaceous quartz schist, and mica schists (metamorphosed sandstone, impure sandstones, and shales) at various horizons indicates that the volcanic action was interrupted from time to time and that sedimentation went on locally over the volcanic surface. These sedimentary beds were later buried by renewal of volcanic eruptions.

In a paper previously referred to,[8] the writer considers the Abrams and the Salmon formation member of a single terrane for which is suggested the name Siskiyou from the wide exposure of these beds in the Siskiyou Mountains where they were first described. These formations, though of different ages, form a distinct stratigraphic group since they are much more highly metamorphosed than any of the later formations so far known from this region and their degree of recrystallization is similar. Their geologic age is uncertain. Pebbles and boulders of rocks similar to the Abrams and Salmon schists are included in the overlying Chanchelulla conglomerates and the difference in degree of metamorphism between the Chanchelulla and the strata of the Siskiyou terrane everywhere is striking. Therefore, a long time of the earliest Paleozoic intervened between the deposition of the Abrams sediments and the eruption of the Salmon volcanics and the invasion of the middle Devonian Kennett sea, but the periods involved can not as yet be stated. The writer believes that the Siskiyou formations are definitely pre-Silurian[9] and probably pre-Cambrian though as yet proof of this is lacking. Some time elapsed between the deposition of the Abrams sediments and the eruption of the Salmon lavas, but there is yet no basis for determining their relative ages.

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[8] Hinds, N. E. A., *op. cit.*, p. 387.
[9] Hinds, N. E. A., *op. cit.*, p. 391.

Pre-Kennett Middle Devonian

Chanchelulla formation

In the western Klamath, a very thick series of sediments of undetermined age unconformably overlies the strata of the Siskiyou terrane with moderate angular and distinct erosional unconformity and forms a broad belt running from the edge of the Cretaceous overlap on the subjacent complex in the Red Bluff quadrangle northwestward through the Weaverville and Big Bar quadrangles, and perhaps beyond. The full extent of the formation has not been ascertained. The base of the sequence is composed largely of thinly bedded gray or much less commonly red and green cherts which have suffered extensive recrystallization to massive or platy quartzites. The original stratification of the cherts shows in most exposures. Interbedded with the cherts are micaceous, graphitic, and calcareous schists, quartzite, metaconglomerate, marble, some of which is graphitic. Toward the top of the formation, the proportion of mica schist, partially metamorphosed sandstone and conglomerate, and limestone is considerably greater though chert continues as an important element. The total thickness exceeds 5000 feet. The strata have been strongly folded and moderately metamorphosed, though the recrystallization has been much less intense than in the Siskiyou terrane.

This formation has not been recognized in previous discussions of the stratigraphy of the southern Klamath. The writer therefore proposes for it the name *Chanchelulla* from the excellent exposures on the slopes of a mountain of that name in the northwest corner of the Red Bluff quadrangle. A more detailed description of the lithology and stratigraphy of this formation will be published in the preliminary report on the Weaverville quadrangle now in preparation.

After the sediments had been deposited, they were flooded by great volumes of basic magma which solidified chiefly as sills of andesite and andesite porphyry, some of which are 200 to 500 feet in thickness and have great areal extents. Dikes and a few irregular bodies also are present. Since their intrusion, these rocks have been metamorphosed to greenstone or chlorite schists. The date of this volcanic episode is uncertain. Mineralogically the meta-andesites very closely resemble the Copley volcanics subsequently to be described and their degree of metamorphism is similar to that of the Copley rocks. The suggestion is strong from these facts and from field relations observed in a few places that the basic rocks in the Chancelulla formation are intrusive phases of the Copley meta-andesite, but this needs confirmation by further studies.

The age of the Chanchelulla sediments has not yet been determined. Radiolarian remains are present in the cherts but have been more or less damaged by recrystallization of these rocks. The limestones in all cases examined have been completely recrystallized and fossils, if originally present, have been destroyed. None have been found in other types of sediments. The formation overlies the beds of the Siskiyou terrane with pronounced erosional and slight angular discordance. The presence in certain of the Chanchelulla conglomerates of metamorphic rocks apparently derived from the Siskiyou beds indicates that the time interval separating them is long.

The Chanchelulla in turn is overlain by remnants of the once great Copley lava plateau which is of pre-middle Devonian age. Thus Chanchelulla is a pre-Copley formation belong to some Eo-Paleozoic period.

The Chanchelulla meta-andesites bear close megascopic resemblance to certain of the Copley volcanics subsequently to be described, though they more commonly possess schistose structures than do the Copley rocks. The meta-andesites are grayish green, olive green, or dark green in color and in texture range from medium to aphanitic. Porphyritic varieties with plagioclase and augite as the visible phenocrystic minerals are dominant. Along shear zones, dark green, fine-grained, highly foliated chlorite schist has been developed.

Microscopic examination shows a wide variety of textures and structures. The original rocks were augite and hypersthene andesites and andesite porphyries composed of medium or calcic andesine, augite or hypersthene, and accessory magnetite and apatite. Metamorphism has converted the rocks to massive or schistose greenstones. In the massive types, relic grains of the original minerals are rather plentiful so that the initial characters can be determined. The feldspars have partly gone over to sericite, calcite, and kaolin; the ferromagnesians to chlorite, epidote, zoisite, calcite, and in a few cases to green hornblende. Further recrystallization has more or less completely destroyed the original minerals and chlorite schists have been produced. In most sections examined, the schistosity is only rudely developed, but where metamorphism has been specially intense, as along shear zones, highly foliated chlorite schists are present.

Copley Meta-Andesite

The description of the Copley meta-andesite is taken with modifications from an earlier paper by the writer.[10]

Widely distributed though the Klamath and Siskiyou mountains are remnants of a great volcanic series called by Diller the Copley meta-andesite. The principal areas of this formation in the region mapped lie in the western half of the Redding quadrangle and the eastern half of the Weaverville quadrangle along the boundary between the two, but other areas have been mapped or reported farther to the west in the Red Bluff, Weaverville, and Big Bar quadrangles, and to the north in the Shasta quadrangle. Objection may possibly be raised to the correlation of certain isolated patches in the western and northern Klamath-Siskiyou region with the Copley, but their stratigraphic relations and lithologic characters so closely resemble those of the main exposures that little doubt can be entertained regarding the validity of such correlation.

The Copley formation consists of fissure flows of pyroxene andesite and less commonly of basalt with which are interbedded large volumes of coarse and fine pyroclastics. Dikes and sills, which appear to have been erupted during this volcanic epoch, are present. The complex at some time prior to the middle Devonian formed a lava plateau of considerable extent. The area over which exposures are present is about 3500 square miles but this doubtless represents only a fraction of the original extent. Subsequent deformation and metamorphism have greatly altered the structure of the plateau and the character of its rocks and long continued erosion has stripped away large areas and has reduced the thickness of the remaining parts. The present thickness in most places is difficult to determine; in the Redding district Diller estimated about 1000 feet, but Louderback[11] has recently described part of a much thicker section near Kennett on the Sacramento River. The writer has measured two sections in the Weaverville quadrangle which exceed Diller's figures, but in neither case is the total thickness exposed. One on Stacey Creek measures more than 1200 feet, the second on Shirttail Peak about 1500 feet. Many good exposures are unsuitable for measurement since metamorphism has destroyed virtually all evidence of structure.

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[10] Hinds, N. E. A., *Op. cit.*, pp. 393-400.

The partial section examined by Louderback was studied in the field and by means of drill cores in connection with surveys for a dam site. A few details are given below:

West side of Sacramento River—elevations measured above the river.
- Elevation 400–600 feet—prominent outcrops of agglomerate.
- 300 feet—fine-grained, somewhat schistose andesite. In part this rock has been converted to chlorite schist.
- Government road to 270 feet—dull, ochreous, friable, "shaly" meta-andesites followed by badly weathered amygdaloidal andesite.
- 145 feet—amygdaloidal andesite.
- 150–155 feet—chlorite schist.
- At and near river—agglomerate composed of andesite fragments.

East side of Sacramento River
- Near river—amygdaloidal and porphyritic meta-andesite with bands of chlorite schist. Fragmental types increase in volume to end of measured section at an elevation of 370 feet above river. In this section are dikes of augite diorite and dacite porphyry which apparently are younger than the Copley. The section was measured nearly at right angles to the strike which is approximately parallel to the course of the Sacramento River at this point. The strata dip at angles which do not depart more than 20 degrees from the vertical. The thickness included between the east and west limits is about 2000 feet, but this probably is considerably less than the total thickness of the Copley in the area.

The Copley volcanics everywhere have been metamorphosed to greenstone schists but the intensity of recrystallization varies from place to place. In some areas a considerable proportion of the original minerals of the lavas and pyroclastics can be readily determined. Porphyritic flows, vesicular and amygdaloidal lavas, and brecciated zones of blocky or clinkery lavas are not uncommon. Beds of tuff, breccia, and agglomerate are abundant so that much may be learned from such exposures regarding the plateau and the composition and structure of its rocks. Sills and dikes have been distinguished at a number of localities. More commonly, however, metamorphism has destroyed the initial structures and textures and the exposures are composed of relatively homogeneous, massive or schistose rocks. Detection of the original relations also is impeded by weathering which has produced a reddish or brownish oxidized layer giving a homogeneous appearance even to very large exposures.

Along shear zones and near the contacts with the large subjacent intrusions, the Copley volcanics have been again recrystallized to chlorite and less commonly hornblende schists. The latter in many places are difficult to distinguish from the Salmon schists previously described and a careful study of the stratigraphy or tracing of the schists into the normal Copley rocks is necessary for their correct identification. An especially fine development of such a schistose phase is in the great roof pendant between the Mule Mountain and Shasta Bally quartz diorite intrusions of Jurassic age in the southeastern quarter of the Weaverville quadrangle. Certain geologists have considered this schist a separate formation unit, but to the north and east it grades into the normal Copley and consequently its true relationship can be positively established.

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[11] Bailey, P., The Development of the Upper Sacramento River. Bull. 13, State of California, Dept. of Public Works, pp. 56-59, 1928.

In this zone and others of similar character subjacent metamorphism has been especially intense and has been superimposed on an earlier metamorphism which had converted the basic rock into massive metabasic equivalents.

Along the larger shear zones, belts of chlorite schist are commonly developed. An excellent example may be studied along the fault system at the head of Modesty Gulch about three miles northwest of Oak Bottom on which the Ganim mine is located. Dynamic and thermal metamorphism have converted the massive meta-andesite into talc and chlorite schist which in certain zones are abundantly impregnated with pyrite and with subordinate amounts of chalcopyrite. At the Ganim Mine this sulphuretized zone is well exposed at the surface, while in a tunnel which cuts the fault zone a large body of massive and schistose talc of high grade has been encountered.

Along the splendidly exposed normal fault at the La Grange Mine about five miles west of Weaverville, chlorite schist has been developed from the meta-andesite. Where the rocks are broken by many small faults, alternations of massive andesite and chlorite schist are generally present. In all areas of the Copley which the writer has examined, these schistose zones are abundant.

The most conspicuous fragmental rocks are breccias and agglomerates in which the fragments range from 4 to 8 or 10 inches in diameter, though in many places masses from 2 to 3 feet in diameter are present. Tuffs are common and probably are much more abundant than the exposures indicate since they have been converted into massive metamorphic equivalents and megascopially bear close resemblance to finely granular, massive lavas. All of the tuffs so far observed are lithic crystal types with fragments rarely exceeding one inch in diameter. The coarser pyroclastics generally are recognizable because of the difference in color between the matrix and the fragments or because of differential weathering which has caused the fragments to stand either above or below the general surface of the rock. These effects are conspicuous both on fresh and weathered surfaces. The pyroclastics are dominantly andesitic; basalt, quartz porphyry, dacite, granite, granodiorite, and diorite fragments are present in minor amounts. In certain areas quartz porphyry fragments are rather abundant.

The typical Copley lavas and pyroclastics are yellowish green, grayish green, and dark green in color. The prevalent greenish shade is due to the general development of chlorite from the ferromagnesian minerals. Not infrequently, epidote is so abundant that it imparts a yellowish green hue to the rocks. The weathered surfaces are brown, yellowish brown, reddish brown, or red. Porphyritic textures are common with augite and plagioclase as the chief phenocrystic minerals. Occasional grains of magnetite also are visible to the eye. Many of the flows are amygdaloidal and their presence is of great assistance in working out original structures. Quartz, calcite, and less commonly chlorite are the chief vesicle fillings. Rather well developed flow structure is present in certain lavas. Where metamorphism has obliterated original textures and structures, large areas and considerable thicknesses appear as homogeneous, fine- and even-grained rocks in which it is impossible to detect flow surfaces or the bedding planes of pyroclastic deposits. Slaty cleaverage is rather conspicuous in certain of these areas.

In certain areas the stratigraphic relations of the Copley are easily determinable; in others either faults bring the volcanics in contact with the adjacent formations or else the contacts are not exposed. In the western Klamath the volcanics lie with pronounced angular and erosional discordance upon the rocks of the Siskiyou terrane and appear to be similarly related to the Chanchelulla strata. Farther to the east the base of the Copley is nowhere exposed. In the Redding district the middle Devonian Kennett formation, or more commonly the Mississippian Bragdon, lies upon the deformed and eroded surface of the Copley. The exposures of the Kennett-Copley contact are limited but it is clear that the Kennett was laid down upon the eroded surface of the Copley lava plateau; contacts between the Bragdon and Copley formations are more commonly met than those between the Kennett and the Copley. The basal Bragdon and also the basal Kennett strata in places are composed of detritus apparently derived from the Copley volcanics. Pebbles of greenstone are found in the conglomerates and certain of the Bragdon sandstones contain large quantities of plagioclase feldspar, chlorite, and ferromagnesian minerals petrographically similar to the components of the volcanics.

No interbedded sedimentary rocks have so far been found in any of the Copley exposures so that interruptions in the volcanic history are not indicated by field evidence so far at hand. That such interruptions occurred and that sedimentation went on over the temporary surfaces of the plateau are very probable and further study of the areas of the Copley may reveal intercalated beds of sedimentary origin.

From the previous discussion it is evident that positive determination of the age of the Copley at present can not be made. The formation is separated from the middle Devonian Kennett sedimentation by a period of folding and erosion and hence must considerably antedate the Kennett formation.

Devonian

Kennett formation

The Kennett formation of Middle Devonian age is the oldest fossiliferous sequence in the Klamath Mountains and consequently is of great importance in the determination of the stratigraphy of the region. The formation is made up chiefly of black shales and slates which are in places highly siliceous; thin-bedded sandstone; and lenses of highly fossiliferous, dark gray to bluish gray limestone, most of which has been recrystallized to marble.

The Kennett formation appears only in the Redding division of this map sheet. The best exposures lie on the western side of the Sacramento Canyon to the west and north of the old mining town of Kennett about 16 miles north of Redding. The principal area is located on both sides of Little Backbone Creek and extends eastward across the Sacramento River; here the limestones are thick and extensive and form bold outcrops along the upper slopes of the Sacramento Canyon. Other areas are located (1) on the southern side of Little Backbone Creek, (2) near the summit of Bohemotash Mountain, (3) on the eastern slope of O'Brien Mountain, (4) east of Kennett and extending on both sides of Sacramento River, (5) on the south slopes of Bass Mountain and extending out into the adjacent flat, (6) south of the old settlement of Churntown, (7) east of Newtown, (8) about 4 miles west of Redding and immediately south of the bend of the Sacramento River. Other smaller areas also are present. A section of the Kennett along Backbone Creek north of the town of Kennett measured by Stauffer,[12] is given below:

Mississippian	Thickness in feet
Bragdon formation:	
9. Conglomerate with quartz pebbles and fossiliferous fragments, these latter often dissolved leaving holes	30
Devonian	
Kennett formation:	
8. Shale, mostly dark, with thin sandy beds	140
7. Limestone, massive, light gray with a small amount of chert. This rock has been quarried to some extent on Quarry Ridge. Part of it is filled with corals	100
6. Sandstone, thin-bedded, and dark gray shale	140
5. Limestone, dark gray to bluish	10
4. Shale, cherty, gray	150
3. Limestone, thin-bedded to massive, often cherty and parts of it full of various types of corals. A black chert band at the base	200
2. Shale, siliceous, often sandy and usually very thin-bedded. Shales mostly black to gray in color and often partly metamorphosed	65
Balaklala rhyolite:	
1. Reported as rhyolite, but is an intrusive igneous mass (alaskite porphyry). A greenish and grayish rock with phenocrysts of quartz and feldspar	

The sections exposed in the other areas are less complete.

The Kennett lies unconformably upon the deformed and eroded Copley volcanics and the basal strata of the Kennett contain rock fragments very evidently derived from the latter rocks. Above, the Bragdon strata of Mississippian age lies unconformably on the Kennett. Before the deposition of the Bragdon there had been very extensive erosion of the country and therefore the Bragdon strata lies upon disconnected erosion remnants of the Kennett beds.

According to Stauffer,[13] an abundant fauna consisting chiefly of corals present for the most part in the limestones are indicative of a Middle Devonian age.

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[12] Stauffer, C. R., The Devonian of California: Univ. Calif. Publ., Bull. Dept. Geol. Sci., vol. 19, pp. 95-96, 1930.

[13] Stauffer, C. R., *op. cit*, p. 104.

Carboniferous. Mississippian

Bragdon formation

The Bragdon is the most widely distributed sedimentary formation in the southern Klamath Mountains. The main area occupies the northeastern quarter of the Weaverville district and the northwestern quarter of the Redding district and extends far to the north into the Shasta quadrangle. Smaller exposures are numerous in the western part of the Weaverville district and two exposures, one at Harrison Gulch and the second on Jerusalem Creek, are located in the northwestern part of the Red Bluff quadrangle. The formation is composed chiefly of thin-bedded shales which are commonly slaty; medium to fine-grained, generally dark gray, very firmly cemented sandstone; and conglomerates in which the pebbles are chiefly quartz and chert. The formation probably exceeds 6000 feet in thickness although the actual measurements are difficult to obtain because of complication by folding. The Bragdon unconformably overlies erosion remnants of the Kennett formation but more commonly is either in erosional contact or fault contact with the still older Copley meta-andesite; evidently long emergence accompanied by widespread and deep erosion took place after the close of Kennett submergence.

The great bulk of the Bragdon formation is composed of thinly bedded slates or shales which are generally gray in color or even black where the carbon content is especially high. These shales and slates probably compose more than 90 per cent of the formation. The sandstones generally consist chiefly of chert and quartz grains, but certain sandstones near the base of the formation contain large quantities of debris from the Kennett and Copley formations. In the conglomerates also are abundant fragments coming from both of these underlying series; in places these rocks contain fossiliferous Kennett limestone pebbles. The fossils found in the Bragdon indicate its Mississippian age. The fossils are scarce and many are poorly preserved. Within the Bragdon formation in the Redding quadrangle is the important volcanic sequence called the Bass Mountain basalt which is subsequently described, and besides this there are many horizons of tuffaceous sandstone and slate. Tuffaceous elements are also present in certain of the sandstones.

Bass Mountain basalt (Bass Mountain diabase of Diller).

Diller[14] described the Bass Mountain diabase as a series of flows, tuffs, and volcanic and other sediments forming a part of the Bragdon formation in the Redding quadrangle. The application of the term ''diabase'' to these surficial eruptives is objectionable in view of the tendency among many geologists to confine the term to intrusives possessing the special texture known as ''diabasic''; hence Bass Mountain basalt is used.

There are two principal areas in which the volcanics are exposed: (1) on Bass Mountain and southward to Newtown in the central part of the Redding quadrangle, and (2) discontinuous patches along Middle Salt Creek, a tributary of the McCloud River in the northern part of the same district. At the first locality the volcanics rest unconformably on the Copley meta-andesite and the Kennett formation and are interbedded with and overlain by Bragdon strata. Diller stated that the various associations exhibited by the Salt Creek section indicate "contemporaneous volcanic activity in the later part of the Bragdon epoch" and that the rocks of the Bass Mountain area probably also belong to the same horizon, "though the evidence is not altogether satisfactory. On Bass Mountain it appears that the eruptions were taking place contemporaneously with the deposition of Bragdon sediments, but whether this activity was contemporaneous with that at Salt Creek is not yet determined."

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[14] Diller, J. S., *op. cit.,* p. 7.

The Bass Mountain lavas are dense, dark gray or greenish gray, medium- to fine-grained rocks in which plagioclase, augite, olivine, chlorite, magnetite, and less commonly hornblende and quartz are visible to the eye or under a hand lens. Porphyritic textures are common with augite and plagioclase as the chief phenocrysts. A few flows are amygdaloidal.

Microscopic examination shows that most of the lavas are holocrystalline, generally porphyritic, and possess either ophitic or intergranular textures. Two sections show a considerable amount of completely devitrified glass. Microphenocrysts of plagioclase (labradorite to bytownite), augite, and in some specimens olivine are set in a groundmass of plagioclase, augite and accessory magnetite and apatite. The phenocrysts are more or less completely altered to calcite, sericite, and kaolin; the groundmass individuals are fresher and from them the composition of the plagioclase is readily determined. Colorless augite is the principal ferromagnesian mineral; both phenocrysts and groundmass individuals are extensively chloritized. Epidote, calcite, and fibrous green hornblende also have been developed from the augite. Where olivine is present, the crystals have been almost completely serpentinized. Certain of the lavas in the Bass Mountain area contain light brown hornblende as well as augite and their plagioclase is calcic andesine.

Fine- to medium-grained lithic tuffs are present in the series and probably exceed the flows in volume. These rocks are dark colored, very firmly lithified and are composed of fragments of basalt like those of the Bass Mountain flows.

Baird formation

Overlying the Bragdon sediments with apparent conformity is the Baird formation containing an abundant fauna which J. P. Smith[15] correlates with the higher divisions of the Lower Carboniferous of the Mississippi Valley and the Lower Carboniferous of the Eureka district, Nevada. The upper part of the formation, which contains most of the fossils, consists of 150 to 200 feet of sandstone and calcareous and siliceous slates most of which are tuffaceous. Below are about 500 feet of tuffs and less abundant tuffaceous sandstones and slates. As originally defined by J. P. Smith, the formation includes about 500 feet of "black metamorphic siliceous shales" below the McCloud limestone, but Diller extended the lower limit to include "the tuffaceous rocks and the adjoining sandstones and shales which overlie the topmost Bragdon conglomerate."

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[15] Smith, J. P., Metamorphic Series of Shasta County, California, Jour. Geol., vol. 2, pp. 595-597, 1894.

From the Pit River northward, the Baird forms an irregular belt ranging from one-half to two and one-half miles wide. On the west the strata generally are in contact with the dike of augite diorite previously referred to, which rose along the plane of separation between the Baird and the overlying Permian McCloud limestone. South of the Gray Rocks, the Baird is represented by a narrow belt about one-fourth of a mile wide.

At various localities the tuffs and sandstones are well exposed; the best sections lie immediately north of the fishery and along the Pacific Highway where it starts across the hills from the McCloud into the Little Sacramento Canyon. The tuffs exposed near the fishery are medium to dark gray, well lithified rocks in some of which angular fragments of andesite and rhyolite up to one inch across are abundant. Many of the tuffs are fine-grained, but under the microscope are similar in composition to the coarser varieties.

Farther up the McCloud Canyon along the Salt Creek road, Diller[16] records fine exposures of the tuffs which he describes as made "wholly of volcanic material and crowded with feldspar microlites, but most of it rhyolitic. Some of the fragments are devitrified, showing traces of original perlitic cracks; others contain anhedral quartz embedded in a mosaic of quartz and feldspar."

Permian

McCloud limestone

The McCloud limestone, conformably overlying the Baird formation and in turn overlain by the Nosoni beds along the west side of the McCloud canyon, can be traced more or less continuously from the northern border of the Redding quadrangle for about 25 miles to the south where it disappears near the settlement of Lilienthal. At its southern extremity, the limestone appears as lenses, but a short distance to the north it gradually thickens, becomes continuous, and, north of the Gray Rocks, is a prominent member of the stratigraphic column. The limestone is exceedingly resistant to erosion and forms bold, rugged ridges or mountains wherever it is exposed; along the eastern side of the McCloud River, great, jagged limestone peaks are the most conspicuous feature of the landscape. The McCloud, through most of its thickness, is composed of pale gray to dark gray fine-textured marble; practically none of the original limestone remains. Most of the rock is massive, but finer-stratified zones also are present. Locally, and especially along igneous contacts, the recrystallization has been much coarser and generally the gray color has been bleached out leaving a very pale gray or white rock. Chert layers, lenses, and nodules have been developed apparently as a result of metamorphism by solutions associated with igneous intrusions; these siliceous zones are more resistant to weathering than the limestone and consequently they stand out rather conspicuously from the limestone surfaces. They are also pale brownish or buff in color and contrast with the normal gray of the limestone. At the southernmost exposures near Lilienthal, the McCloud is about 200 feet thick while along the east side of the McCloud Canyon it reaches a maximum of 2000 feet on Horse and Town mountains. The McCloud limestone is so highly fossiliferous that most weathering surfaces show some representation of the fauna. Beds composed of cup corals, protozoa, and crinoid stems are common. Internal structures have been commonly destroyed by recrystallization. The fauna consists chiefly of corals and protozoa (Fusulina); brachipods and gastropods are fairly abundant. Crinoid stems in great profusion are present but complete individuals are rare. According to Diller[17] the age of the McCloud is Pennsylvanian, but recent work by H. A. Wheeler[18] of Stanford University has shown that the fauna is of Lower Permian age and that the Pennsylvanian is not represented in this region.

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[16] Diller, J. S., *op. cit.*, p. 3.

While the McCloud was laid down on the Baird strata, it is at present separated from the Baird throughout much of its extent by an enormous dike-like body of quartz augite which apparently came up along the contact of the two formations. The Baird and McCloud are in contact north of Hirz Mountain for about four miles and also south of Gray Rocks for about four miles. As a result of the intrusion of the diorite, the limestone was very greatly shattered and many huge blocks or xenoliths were engulfed in the dike-rock. These show up as isolated masses completely surrounded by the augite diorite along the whole length of the dike. Many of these xenoliths show more intensive recrystallization than the average of the formation. Along the contacts of the igneous body and the limestone, a considerable suite of metamorphic minerals have been developed of which hedenbergite, magnetite, and garnet are the most conspicuous. Small bodies of magnetite or magnetite rock containing various proportions of other minerals, principally garnet, are found along the contact within the limestone or within the igneous rock. Some magnetite was mined from these bodies on the west side of the McCloud canyon near the post office of Baird about one and one-half miles north of the junction of the Pit and McCloud rivers. The limestone has been used for flux at mines of the Bully Hill district farther to the east.

Nosoni formation

Diller[19] described under the name Nosoni formation a group of volcanics and sediments lying between the Pennsylvanian McCloud limestone and the Triassic Dekkas andesite. Fossils, which are exceedingly abundant in certain zones, were believed to indicate a position at the top of the Carboniferous, but later studies have shown that a Permian age is more probable.

The major part of the Nosoni is composed of lithic crystal tuffs and agglomerates made chiefly of basaltic fragments; crystals of plagioclase and femic minerals; flows of andesite and of olivine basalt also are present. Interbedded with the volcanics and dominant in the uppermost part of the formation are sedimentary strata which included dark brown, fossiliferous, shaly limestones which have been subjected to extensive silicification; dark gray to brown, medium grained, shaly, tuffaceous sandstones; and dark gray tuffaceous shales and slates. Fossils are present in the sandstones and shales as well as in the limestone.

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[17] Diller, J. S., *op. cit.*, p. 4.
[18] Wheeler, H. A., Private communication.
[19] Diller, J. S., *op. cit.*, p. 5.

The lavas Diller describes as

> "dark and compact, with uneven fracture. In most cases they are holocrystalline, decidedly microporphyritic, and made up chiefly of plagioclase, with much augite, less magnetite, and occasional olivine or iddingsite. The tabular feldspars are enclosed in a groundmass having interstitial structure modified by fluidal movement giving the lath-shaped crystals of labradorite a parallel, stream-like arrangement with the granular augite and oxides of iron between them. Augite occurs sparingly among the phenocrysts, but olivine or iddingsite is common though neither appears in the groundmass and both are sometimes entirely absent."

Most of the lavas show considerable alteration with chlorite and calcite as the chief secondary minerals developed. In the few flows which are amygdaloidal, calcite, quartz, and chalcedony are the chief vesicle fillings; chlorite also is present.

The Nosoni forms a belt ranging from three-eighths of a mile in width near the overlap of the Cretaceous and Tertiary formations on the subjacent complex to 3½ miles wide along the northern margin of the Redding quadrangle. Northward in the Shasta area, the formation passes under the Columbia-Cascade lavas. The well exposed section on Horse Mountain east of Baird is about 500 feet thick while on Nawtawakit Mountain 10 miles to the north a maximum of 1200 feet were measured. In these thicker parts the proportion of pyroclastics is greater than to the south. The sediments are chiefly at the top of the formation though sedimentary interbeds are present throughout.

Regarding the relations of the McCloud and Nosoni, Diller[20] writes,

> "The Nosoni conformably overlies the McCloud limestone opposite Horse Mountain and farther south, but to the north the accumulation of so great a mass of pyroclastic rocks beneath the main horizon of fossils suggests an unconformity. However, the occurrence near the bottom of the pyroclastics of small lenses of shale bearing essentially the same fossils as those above the close affinity of the fauna with that of the McCloud limestone strengthen the evidence in favor of conformity."

Recent study of the McCloud-Nosoni contact shows the presence of a pronounced erosional discordance which implies withdrawal of the earlier Permian sea and the deep erosion of the limestone surface followed by reinvasion of the ocean in later Permian time and deposition of the Nosoni beds. The disconformity is particularly well shown in the long subsequent valleys developed in the Nosoni south of the Pit River. According to Beede and Kniker,[21] who have studied the protozoan limestones of the McCloud,

> "in California, the relation of the Permian and Pennsylvanian section is still uncertain because of the meagerness of the data available due to physical conditions of the deposits. However, the association of *Schwagerina robusta* Meek, *Fusulina cylindrica* and *Fusulina extensa* var. *californica* Staff is a normal association which may be expected and is usually found in the regular *Schwagerina* horizons of other regions. * * * As the matter now stands, the age of the California *Schwagerina* beds is not as definitely known as is to be desired, but the balance of evidence seems to be that the beds are referable to the base of the Permian in the sense in which America basal Permian beds are treated in this paper."

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[20] Diller, J. S., *Op. cit.*

[21] Beede, J. W., and Kniker, H. T., Species of the Genus Schwagerina and Their Stratigraphic Significance, Univ. of Tex. Bull. 2433, p. 17, 1924.

In a recent letter, Mr. H. A. Wheeler[22] of Stanford University states that the fauna of the McCloud limestone is lowest Permian and that of the Nosoni formation is probably upper Lower Permian or lower Middle Permian. The abundant fauna of the Nosoni certainly merits further study to determine its exact stratigraphic position.

Triassic

Diller,[23] in mapping the Redding quadrangle, differentiated four members of the Triassic series and briefly described each in the Redding Folio as follows:

Jurassic	Modin formation		
	Unconformity		
Triassic	Brock shale	400 feet	Upper Triassic
	Hosselkus limestone	250 feet	
	Pit shale	2000 feet	Middle Triassic
	Dekkas andesite	1000 feet	
	Unconformity		
Carboniferous	Nosoni formation		

Dekkas andesite.

Dekkas andesite is a thick body of grayish green, green, and deep bottle green flows and interbedded tuffs and breccias. According to Diller,[24] the Permian Nosoni formation is ''overlain, most likely with unconformity, by the great mass of andesitic rocks forming Horse, Town, Minnesota, and Salt Creek mountains. The volcanic rocks are nearly or quite alike, and the only guide in drawing the line has been the occurrence of fossils characteristic of the Nosoni formation. No characteristic fossils have been found in this great body of volcanic rocks next above the Nosoni, but in the strata overlying the volcanics characteristic Triassic forms occur, and they are so different as to suggest a decided break somewhere between the Nosoni and Pit formations.''

On a later page (p. 8), he further states that ''the relation (of the Dekkas) to the Nosoni formation as outlined is equally clear. The outcrops of the Dekkas andesite and Nosoni formations are approximately parallel for over 20 miles, but the Nosoni belt narrows to the south, and on Campbell Creek, as well as near Lilienthal, it is unconformably overlapped by the andesite flows.

Diller also notes that on Minnesota and Salt Creek mountains, tuffaceous slates, interbedded with the lavas and tuffs of the upper Dekkas, contain many microscopic fossils similar to those found in the overlying Pit slates, a statement which scarcely agrees with his comment that the Dekkas contains no characteristic fossils.

The contact between the Dekkas and Nosoni in most places where the writer has examined it between Horse and Town mountains north of the Pit and the Cretaceous overlap to the south is clearly defined.

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[22] Wheeler, H. A., Personal communication.

[23] Diller, J. S., *Op. cit.*, p. 6.

[24] Diller, J. S., *Op. cit.*, p. 4.

The Nosoni is composed of clastic sediments which to a large extent are tuffaceous, and a goodly proportion of andesitic flows and dark green, andesitic and basaltic tuffs. The Nosoni strata are not very resistant to erosion and, where the dips are steep, have had subsequent valleys eroded into them; where the dips are lower, the great mass of resistant Dekkas lavas above has more or less protected them from erosion. The basal Dekkas consists of massive, grayish green or dark green andesitic flows and firmly lithified pyroclastics of somewhat more salic composition than the Nosoni volcanics. The Dekkas rocks are very resistant to erosion and form bold ridges and peaks especially north of the Pit River where the formation attains its maximum thickness. Between the two formations is a distinct erosional discordance, representing the development of a subaerial landscape after the Permian seas had retreated from this region. No orogenic deformation occurred at this time. The time interval between the Nosoni and the Dekkas is difficult to estimate. The Nosoni, from studies which so far have been made of its fauna, is not later than lower Middle Permian; the exact age of the basal Dekkas volcanics is not known since no fossils have been discovered in any of the pyroclastics. The fossils found in the sedimentary interbeds of the upper part of the formation are Middle Triassic in age.

The Dekkas andesite forms a belt 1 to 3 miles wide extending from the Cretaceous overlap in the central part of the Redding quadrangle northward into the Shasta quadrangle. Splendid exposures are to be found on the north side of the deep Pit River Canyon near the settlement of Heroult. On Town, Minnesota, and Salt Creek mountains, where the formation reaches a maximum thickness of 1000 feet, excellent sections also are available. A smaller area of the Dekkas is brought up in an anticlinal fold along Clikapudi Creek south of Copper City in the east central part of the Redding quadrangle.

The Dekkas is composed of flows, tuffs, breccias, and agglomerates in which pyroxene andesite is the dominant petrographic type. Flows predominate in the basal part while the upper part is comprised chiefly of pyroclastics. Near the top of the Dekkas, interbeds of tuffaceous shale, closely resembling those of the overlying Pit formation and containing Upper Triassic marine invertebrates, become increasingly abundant and form a transition zone into the dominantly sedimentary Pit. The presence of marine fossils in these interbeds shows that a part of the Dekkas was accumulated below sea level, but there is no evidence that this applies to the whole of the formation. The abrupt contact of the volcanics with the erosion surface which had been developed in the Nosoni sequence suggests on the other hand that the early Dekkas lavas were erupted over a land surface and the absence of water-laid strata between the flows in the greater part of the formation indicates that subaerial conditions prevailed during most of the epoch. Towards its close the region occupied by the present southern Klamath mountains gradually sank below sea level and remained submerged during the rest of Triassic time.

Before submergence there had been developed a volcanic plateau surfaced partly by flows and partly by various types of pyroclastics. The area of the plateau is unknown but its original thickness is measured by the maximum thickness of volcanics below the Pit shale for no erosion of consequence appears to have taken place before the Pit submergence and the subsequent burial of the plateau surface by the sediments of that epoch.

The Dekkas lavas are typical pyroxene andesites and basalts which exhibit wide variety of textural and structural features. Extensive chloritization of the ferromagnesian minerals has produced colors ranging from grayish green to deep bottle green. Porphyritic flows with plagioclase and less commonly augite as the phenocrysts, are most common, but fine and even-textured rocks are fairly abundant. Many flows show amygdaloidal and vesicular zones. The pyroclastics are composed chiefly of the same rock types as the flows, though, in addition fragments of acid volcanics and of various types of plutonic rocks are included. Green colors, generally darker than those of the flows, have been developed in the pyroclastics by chloritization of the augite and other ferromagnesian minerals. The microscope shows the rocks to be chiefly highly altered andesites and less quantities of basalt.

Pit formation

As stated above, the Dekkas andesite grades above into the Pit formation by the increase in proportion of tuffaceous slates and shales. The Pit formation, originally called by J. P. Smith [25] the Pitt shale, consists of gray to black shales and slates which are in many cases tuffaceous; lesser quantities of gray, shaly sandstones and sandstone; thinly bedded, impure black cherts; dark gray tuffs; and occasional lava flows. The proportion of pyroclastics, volcanic detritus in the sediments, and lava flows decreases from bottom to top, hence the intense volcanism of the earlier Triassic gradually decreased through the Pit epoch. The Pit was a time of long continued submergence below sea level so that the lava flows and tuffs interbedded with the clastic strata were erupted below sea level and very likely also from vents or fissures close to the coast line. The Pit strata are widely exposed in the Redding quadrangle. Starting as a belt less than two miles wide where they appear at the edge of the Cascade-Columbia lava cap in the Shasta quadrangle, the exposures widen to about ten miles in the highly folded area along the Pit and then decrease to eight or nine miles at the overlap of the superjacent Cretaceous and Cenozoic strata in the central part of Redding quadrangle. The formation has a maximum thickness of more than 2000 feet, though accurate determinations are difficult because of crumpling and faulting.

While the greater part of the Pit formation is non-fossiliferous, poorly preserved invertebrates are present at many horizons, and at a few localities good specimens may be obtained. At the top of the formation are 200 feet of tuff and shale from which Upper Triassic species have been obtained; below at various horizons Middle Triassic types have been collected.

The flows interstratified with the Pit sediments closely resemble those of the underlying Dekkas, that is they are pyroxene andesites in which grayish green or dark green colors have been developed by chloritization of the augite. Petrographically they are identical with the Dekkas types. The tuffs are composed chiefly of crystals of feldspar and of chloritized ferromagnesian minerals. Occasional fragments of slate and of other lavas and plutonic rocks also are present; some slate fragments measure three or four inches across. At several horizons, agglomerates, containing boulders of pyroxene andesite up to six inches across, were found. Gray tuffaceous shales and less common, gray tuffaceous sandstones are abundant throughout the formation; the volcanic constituents are like those of the tuffs described above. These tuffaceous beds at certain localities have been converted to dense, cherty, dark grayish or brownish slates and to dense quartzites. Probably this metamorphism has been caused by the many igneous bodies which were intruded during the late Jurassic deformation which affected this region. These intrusive bodies in some cases show at the surface and metamorphic aureoles follow the contacts; in others their presence must be inferred from the local metamorphism of the Pit strata. Probably under much of the region, igneous masses belonging to this late Jurassic magnatic period are not far below the surface. Metamorphism by deformation alone has not been notable, for in many places little change in the original mineralogy of the rocks has occurred.

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[25] Smith, J. P., *Op. cit.*, p. 601.

Hosselkus limestone

The Hosselkus limestone, lying conformably between the Pit formation and the Brock shale of Upper Triassic age, appears as a series of discontinuous lenses extending from the northern border of the quadrangle near its eastern side southward to the canyon of Cow Creek east of Ingot. The principal exposures are on Brock Mountain, where folding widens the outcrop to nearly two miles. Along the strike this lens extends for about seven miles. The second most important area lies along the canyon of Cow Creek east of Ingot. Other smaller lenses are present north of Brock Mountain. On the north and east slopes of Bear Mountain, 16 miles northeast of Redding and 12 miles southwest of Brock Mountain, there are small exposures of the Hosselkus. The formation according to J. P. Smith[26] is divisible into three lithologic and faunal zones, which are not very sharply differentiated.

	Thickness in feet
3. Hard, siliceous, massive, gray limestone which is abundantly fossiliferous (Spiriferina zone)	50
2. Hard, siliceous, prominently jointed, gray limestone containing abundant but poorly preserved fossils (Atracites zone)	100
1. Hard, pure, thinly bedded, dark blue limestone containing abundant well preserved fossils (Trachyceras zone)	50

In the smaller lenses the thickness is less; according to Diller[27] on Cow Creek the thickness is 160 feet, on the east end of Mewittipom Mountain 75 feet, on Bear Mountain about 50 feet. As previously noted the limestone contains abundant fossils, many of which are beautifully preserved, and a very abundant invertebrate fauna has been described by the late J. P. Smith of Stanford University. Cephalopods and corals are the most important types. The fauna shows an Upper Triassic age. Reptilian remains, obtained on both Bear and Brock mountains, have been described by J. C. Merriam.

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[26] Smith, J. P., *Op. cit.*, p. 606.
[27] Diller, J. S., *Op. cit.*, p. 5.

Brock shale

The Brock shale conformably overlies the Hosselkus limestone at Bear Mountain and also in the eastern part of the Redding quadrangle. On Brock Mountain, where the principal exposures are located, the lower 300 feet are dark and somewhat calcareous while above are grayish and reddish slates. The shales contain a small Upper Triassic fauna.

The principal exposures form a narrow belt extending from the northern margin of the Redding quadrangle southward for about 15 miles. A small area shows in the hilly country north of the canyon of Little Cow Creek and east of Ingot.

In the closing epoch of Triassic time, occasional eruptions of andesitic magma again occurred, for in the lower part of the Brock formation which overlies the Hosselkus are thin beds of andesitic tuffs and tuffaceous shales. In exposures of the upper Brock strata seen by the writer, volcanic detritus does not appear and Diller does not record its presence in the more extensive areas which he studied. So far as the record shows, volcanic activity was not very intense and died out early in the Brock epoch. The Brock tuffs and tuffaceous shales are similar to those of the Pit formation, that is they are andesitic in composition.

On Bear Mountain Diller suggests the presence of Brock shale, but did not identify it. Between the Hosselkus limestone and the basal Modim agglomerate, there are about 40 feet of thinly bedded, dark gray shales and tuffaceous shales closely resembling the Brock shale farther to the east which certainly must be assigned to the formation. Thin beds of andesitic tuff also are present.

A few species of pelecypods and cephalopods are fairly abundant in most of the Baird exposures.

Jurassic

A. *Pre-Nevadan*

In the Redding quadrangle, Diller [28] divided the very thick and areally extensive Jurassic sequence into three formations, the Modin below, the Bagley andesite, and the Potem above.

1. *Modin formation*

The lowest member of the Jurassic in the southern Klamath was named the Modin formation by Diller [29] from exposures near the mouth of Modin Creek in the northeastern part of the Redding quadrangle. The formation comprises "tuffaceous beds, overlain by a greater mass of compact, fine gray shaly sandstones and shales, with a few small lentils of limestone." At the base is a thick volcanic agglomerate consisting chiefly of andesite debris but containing also abundant fragments of the underlying Triassic formations notably the Hosselkus fossiliferous limestone. The volcanic boulders rarely exceed one foot in diameter. On Bear Mountain about sixteen miles northeast of Redding this agglomerate zone is about 400 feet thick. The sandstones are fine-grained, gray in color, commonly thinly bedded, and have associated with them shaly layers. Thin limestone lentils, 10 to 20 feet and 12 to 18 inches thick are interbedded with the sandstones. Near Bagley

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[28] Diller, J. S., *op. cit.*, pp. 5–6.
[29] Diller, J. S., *op. cit.*, p. 5.

Mountain, in the northeastern part of the Redding quadrangle, are larger limestone bodies, one of which is a mile long and 200 feet thick. The principal exposures form a belt two to four miles wide extending from the north side of Cow Creek in the eastern part of the Redding quadrangle to its northern border about seventeen miles distant. The belt continues for a few miles still farther north into the Shasta quadrangle where it passes beneath the Cascade lavas; on the south, it continues into the Lassen quadrangle and again disappears beneath the Cascade lavas. A small, isolated area of the basal volcanics is exposed on the top of Bear Mountain in the central part of the Redding quadrangle south of the Pit River. Diller estimated the thickness of the Modin at about 3000 feet, but does not indicate that a detailed section was measured. On Bear Mountain the volcanics have a thickness of about 400 feet.

The break between the Modin and the underlying Brock in general is slight for the narrow belt of Brock between the Hosselkus and the Modin runs for miles through the northeastern part of the quadrangle with very little change in width. None the less, a distinct erosional and in places a slight angular discordance exists. On Bear Mountain as noted previously, about forty feet of shales and thin tuffaceous beds which certainly belong to the basal Brock since pyroclastics and pyroclastics sediments have not been reported in the upper part of the formation. Between the Modin and the Brock on Bear Mountain is a slight angular and erosional unconformity, hence a moderate deformation of the crust took place in that section. Because of the limited area of the outcrop and its isolated position, evidence favoring either view can not be obtained.

Regarding the age of the Modin, Diller[30] quotes Stanton as stating that fossils from the basal " 'tuff' are of Upper Triassic (Hosselkus) age, but the tuff in which the limestone is found is more probably of Jurassic age. Between the Pseudomonotis horizon (Brock shale) and the beds yielding a well characterized Jurassic fauna (Potem horizon) comparable with that found at Taylorsville, there is a broad belt in which a great thickness of rocks is represented and from which fossils were obtained at many localities. In the field these were considered Jurassic, and I still think that most if not all of them are of that period, but the paleontologic evidence is not so complete as is desirable. The fossils at most localities belong to types that would not aid in discriminating Jurassic from Triassic." Crickmay[31] implies that the Modin should be classed as Liassic in age, since he states that the Bagley volcanics overlie Liassic deposits, though he does not mention the Modin directly.

On Bear Mountain the basal volcanics alone are represented; if the much thicker upper sedimentary part ever were present it has been eroded away. At the base is a coarse agglomerate which consists chiefly of fragments of dark red and black andesites and basalts and great angular fragments of slate and limestone evidently derived from the underlying Triassic embedded in a matrix of fine rock fragments and shattered crystals of plagioclase, hornblende and quartz. The rock fragments range from one-eighth of an inch to two feet in diameter. Higher in the section, the tuffs are finer grained, better stratified, and few conspicuous rock fragments are visible. A single thin bed of gray shale is present near the top of the section. The thickness of these volcanics is about 400 feet.

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[30] Diller, J. S., *op. cit.*, p. 5.

[31] Crickmay, D. H., Jurassic History of North America, Proc. Amer. Philos. Soc., vol. 70, p. 28, 1931.

According to Diller, splendid sections of the entire Modin formation may be found at many places along and north of the Pit River. Between Flat and Potem creeks in the Pit canyon, the basal agglomerate overlies the Brock shales and contains fragments of fossiliferous Hosselkus limestone as on Bear Mountain. Several other agglomerates are present at higher horizons. The upper sedimentary section is well exposed along the Pit.

2. *Bagley andesite*

Under the name Bagley andesite, Diller [32] describes two areas of volcanic rock lying between the Modin and Potem formation, ''one from which the rock takes its name, near the northeast corner of the Redding quadrangle, and the other along the Pit River near the eastern border.'' More than three-quarters of the first area is composed of ''tuff'' which Diller describes as ''sometimes coarse, almost agglomeratic, but generally fine and stratified, with occasional traces of marine fossils.''

Lavas are most abundant near the summit of Bagley Mountain. Diller classes the rocks as andesites, but in his descriptions says nothing about the composition of the feldspars. In the deep canyon of the Pit near the mouth of Potem Creek a magnificent section of the second Bagley area is exposed. Here flows and tuffs are present in more nearly equal proportions, and contemporaneous dikes and sills cut the extrusive rocks. By chloritization of the augite and other ferro-magnesian minerals, the rocks of the Bagley have been converted to greenstones.

Diller states that ''both areas lie practically on the border between the Modin and Potem formations, but do not necessarily indicate an unconformity. These areas represent centers of greater accumulation of volcanic material near points of eruption near the beginning of the Potem epoch. Between these two points the contemporaneous sediments contain some detritus from both centers, but apparently the greater portion comes from a different source. For this reason the intermediate sediments were included in the Potem.''

A brief description of the petrographic characters of the Bagley rocks is given by Diller [33].

3. *Potem formation*

Overlying the Modin formation or the intervening Bagley andesite where the latter is present is the Potem, a formation also named by Diller [34] from the type locality on Potem Creek in the northeastern part of the Redding quadrangle. ''The Potem formation is composed of sandstone, shales, and tuffs. The thin-bedded sandstones and gray, sometimes slaty shales predominate in its lower part and make up the greater part of the formation. They are more or less calcareous and contain a few lentils of limestone. Tuffaceous conglomerates occur sparingly in the lower half of the formation, but in the upper part they are most abundant—in fact, nearly all of the sediments in this part are of igneous material. Some of this may have been furnished by contemporaneous volcanic activity, but most of it was derived by the ordinary processes of erosion from a wide expanse of volcanic rocks.'' As a matter of fact, limestones, shales, and sandstones are fairly abundant in the upper part of the formation, and many of the limy beds contain rather abundant fossils. Whether all of these sediments contain volcanic detritus certainly has not been determined; many of the beds evidently contain very little. The tuffaceous conglomerates of which Diller speaks are chiefly coarse and fine tuffs, though some agglomerates are present.

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[32] Diller, J. S., *op. cit.*, p. 8.
[33] Diller, J. S., *op. cit.*, p. 8.
[34] Diller, J. S., *op. cit.*, p. 5.

The Potem formation is exposed over a considerable area in the northeastern part of the Redding quadrangle and extends into the Modoc Lava Beds quadrangle as far as the Kosk Creek drainage, beyond which it is buried by the great pile of Cascade lavas; magnificent exposures are to be found in the rugged hills of this region so that the stratigraphy can probably be worked out in very considerable detail. To the south the Potem extends into the Lassen Peak quadrangle where again it is buried by the Cascade lavas. Diller estimates the thickness of the formation at about 2000 feet, but gives no details of measured sections. Regarding the age, Diller [35] quotes Stanton as stating that the Potem is ''characterized by a well-marked Jurassic fauna including several species that occur in the Hardgrave sandstone near Taylorsville. Among the forms may be mentioned Rhynconella, Pecten acutiformis Meek, Pecten (Entolima), Pinna expansa Hyatt, Modiola, Gervillia, Lima, Trigonia (several species), Goniamya, Pholadomya, and ammonites of the Coroniceras types, etc. It is probable that horizons somewhat higher than those of the Hardgrave sandstone are included in the formation, but some of the types that seem later, as indicated by their occurrence in the Taylorsville region, are intimately associated with the Hardgrave species. This fauna is very distinct from all those that precede it in this region.'' Hyatt classed the Hardgrave sandstone as Upper Liassic and Crickmay [36] more definitely dates it as Ludwigian. Crickmay writes that the lower part of the Potem consists of sandstone and shale and contains presumably Middle Jurassic fossils,'' and the upper part of ''tuffs and agglomerates which mark the later Middle Jurassic volcanism.''

The igneous rocks of the Potem are chiefly coarse and fine andesitic tuffs; agglomerates are present in a few places and there are occasional andesitic and basaltic flows interbedded with the clastics. Sediments (limestones, sandstones, and shales) containing various proportions of volcanic detritus are abundant especially in the upper part of the formation. These various pyroclastics and flows prove the recurrence of volcanism in the Middle Jurassic after the lapse represented by the dominantly sedimentary phase of the lower Potem. The region apparently stood below sea level during Potem time so that the pyroclastics were either erupted under water or were blown into the oceans by eruptions on adjacent land areas. Volcanics erupted on the lands probably supplied most of the debris present in the sedimentary beds of the lower and upper Potem. The Middle Jurassic thus was a time of intense volcanic activity in the Klamath and also in the Sierra Nevada region where pyroclastics and flows were accumulated over large areas in considerable thicknesses.

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[35] Diller, J., Geology of the Taylorsville Region, California, U. S. Geol. Surv., Bull. 340, p. 40, 1908.

[36] Crickmay, C. H., Jurassic History of North America, Proc. Amer. Philos. Soc., vol. 70, p. 29, 1931.

Late Jurassic (Nevadan) intrusives

During the later part of the Jurassic, the earth's crust in the Klamath-Siskiyou region was strongly folded and faulted; mountain ranges of some magnitude were developed. As this deformation progressed large volumes of granitoid magma were intruded into the crust and solidified chiefly as various types of diorites. Later parts of this intrusive complex were exposed by erosion as dikes, sills, chonoliths, stocks, bosses, and batholiths. Those included within the boundaries of the mapped area are briefly described.

1. *Plutonic bodies*

The largest bodies include a small ''batholith,'' numerous stocks and bosses, and a great, irregular plutonic dike all of which apparently represent the higher domes and ridges of a granitoid complex present under much of this region. Farther north and west in the northern Klamath and in the Siskiyou ranges are other similar granitoid bodies probably intruded at the same time and belonging to the same complex.

a. *Trinity Alps stock-boss cluster*

North of Weaverville, the county seat and chief town of Trinity County, in the high, rugged mountains which are locally known as the Trinity Alps, is a cluster of stocks and bosses of quartz diorite. The stocks form high peaks which are specially conspicuous in the landscape because of the sharp contrast between the light gray color of their rocks and the generally dark shades of the country rocks which are mainly serpentine and hornblende and chlorite schist.

In the rugged walls of the many deep canyons in this section are magnificent exposures of the contacts of the stocks with the country rock. Where their downward extensions are visible, the walls dip away from the rounded summits of the stocks at angles generally exceeding fifty degrees. Many apophyses extend outward from the main bodies, and bays and re-entrants in the walls are abundant so that in detail most of the contacts are very irregular. Where the magma invaded the Salmon schist, offshoots in great numbers have intruded the schist either along the planes of schistosity or at various angles thereto, and thus have developed contact zones of exceedingly complicated structure. Lit-par-lit gneisses have been developed at many places.

The rocks of the various stocks and bosses are pale gray quartz diorites composed of plagioclase, quartz, hornblende, and biotite with accessory magnetite visible under a lens. Chlorite and the weathering products of plagioclase also are visible. The texture is generally coarse and equigranular, but fine grained areas and contact zones are not uncommon. In certain areas, the large size of the feldspars and less commonly quartz and hornblende individuals gives the rock an inequigranular texture. Along some of the contacts a considerable variety of hybrid rocks have been produced by reaction between the magma and the country rock. Autoliths are fairly common in the larger bodies. The microscope shows that andesine composes considerably more than half of the rock, with quartz, green hornblende, brown biotite, and accessory magnetite, apatite, zircon, and titanite making up the residue. Chlorite, epidote, zoisite, calcite, kaolin, and sericite are secondary products.

Aplite and pegmatite dikes are rather abundant in these bodies and extend into the adjacent country rock.

b. *Shasta Bally batholith*

The largest subjacent body in the region lies principally within the southern half of the Weaverville quadrangle, but extends a short distance into the adjacent Red Bluff quadrangle where it passes beneath the superjacent Cretaceous deposits. The exposed part of the batholith is 30 miles long and 10 miles in maximum width; at its northern end it narrows to an irregular dike-like body. In terms of Daly's [37] definition of stocks and batholiths, this intrusive belongs to the second group since its area considerably exceeds the 100 square kilometers which Daly sets as the upper limit for the area of a stock.

In the Shasta Bally batholith there are two rock types which grade into each other—hornblende biotite quartz diorite and hornblende quartz diorite containing a very small percentage of biotite. Some field observers have attempted to establish the existence of two bodies, but a careful examination of the exposed area shows that this is not possible. Along certain contacts, notably with the Mississippian Bragdon slates and the Copley meta-andesite, the rock is medium to coarsely granular biotite-hornblende quartz diorite; along part of the contact with a serpentine intrusive, this phase is fine-grained and in places shows especially large feldspars. The main mass is lighter colored and the percentage of biotite is small; the two types grade insensibly into each other. The biotite-rich phase appears to have been developed along contacts by the assimilation either of Mississippian slates or of basic igneous rocks.

The typical hornblendic phase is a light or medium gray rock of coarse and generally even texture. In the hand specimen plagioclase, quartz, hornblende, biotite, and magnetite are visible. The microscope shows that the feldspar, ranging from basic to acid andesine, composes more than 60 per cent of the rock. The residue consists of quartz, green hornblende, green biotite, and accessory magnetite, titanite, and apatite.

c. *Mule Mountain stock*

This body lies along the common border of the Redding and Weaverville quadrangles, and is separated from the Shasta Bally batholith by a narrow belt of Copley meta-andesite and Balaklalla granite porphyry. The stock is eight miles in length and four and three-quarters miles in greatest width; its boundaries are exceedingly irregular. The rock is a highly quartzose diorite which locally is quite deficient in ferromagnesian minerals. The texture is generally equigranular, but, in certain quartz-rich phases, many of the quartz grains are considerably larger than the average grain size of the rock. The principal development of this phase is along the indefinite contact with a granite porphyry chonolith which it has intruded.

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[37] Daly, R. A., Igneous rocks and their origin. New York, p. 90, 1913.

The quartz diorite is so deeply weathered that fresh specimens are difficult to secure.

The principal rock type is composed of albite or albite-oligoclase, quartz, green hornblende, small amounts of green biotite. A small amount of orthoclase is present. Magnetite, titanite, and scattered crystals of apatite are the chief accessories. Kaolin, sericite, and calcite are alteration products of the feldspars; epidote, chlorite, zoisite, and calcite of the hornblende and biotite.

A few deeply weathered autoliths and scattered pegmatite and aplite dikes are present.

d. *Pit River stock*

The Pit River stock is a small body of quartz diorite about three miles long and one and one-half miles wide which is well exposed in the canyon of the Pit River near the Pacific Highway bridge.

The typical rock is a medium to coarse grained light gray rock with certain phases showing specially large quartz grains which give it a pegmatoid structure. Plagioclase, often pale pink in color, and chloritized ferromagnesians, epidote, magnetites, and chlorite, are the other megascopic minerals.

Aplite dikes are common and the rocks are almost white, sugary textured, and contain little or no visible ferromagnesian minerals.

e. *Redding quartz augite diorite plutonic dike*

One of the most interesting plutonic intrusives in the southern Klamath Mountains is a huge, irregular, dike-like body of quartz augite diorite which extends far more than 20 miles southward from the northern border of the Redding quadrangle along or close to the McCloud River. How far it projects into the Shasta quadrangle is not known, but, judging from the narrowness of the dike at the boundary of two sheets, the exposed distance can not be great. The southern end continues for about two miles south of the limit set by Diller, so the total length of the dike must exceed 25 miles. The maximum width is two and four-tenths miles and the average width about one mile. Throughout most of its course the magma rose along the contact between the Mississippian Baird formation and the Permian McCloud limestone, but, during the process of intrusion, active stoping took place so that the contacts are distinctly irregular. The McCloud limestone in particular was greatly shattered and, along the course of the dike, are many xenoliths and roof pendants of this rock, and also of the Baird and Nosoni rocks.

The principal contacts as stated above are with the Mississippian Baird formation and the Permian McCloud limestone, but in a few places the dike transgresses the Permian Nosoni formation and the early Triassic Dekkas formation. At two localities, there are fairly long stretches of contact with the Dekkas andesite, the youngest formation cut by the main dike. One of these extends from the North Gray Rock for over two miles to the north side of the Pit River canyon; the second extends from Dekkas Creek also for two miles to the south side of Campbell Creek. Dike-like and irregular apophyses can be traced from both sides of the main body and many isolated intrusives of the same rock type are present close or at some distance from the main dike. On the west the dike and its offshoots cut principally Mississippian formations; on the east side the youngest formations which the apophyses intrude are the Triassic Pit and Jurassic Modin formation, but of course the relations of these bodies to the main one can not be proved. The dike certainly is post-Dekkas and probably belongs to the Nevadan intrusives though it was intruded before the Pit River stock which has been previously described.

The rock of the Redding dike exhibits a considerable range of color, texture, and mineral composition. The most common type is a medium- and generally even-grained, dark-green rock in which greenish plagioclase, chloritized augite, quartz, and magnetite are visible in the hand specimen. In certain areas, especially large plagioclase individuals give to the rock an inequigranular texture. Less common is a somewhat coarser grained, medium grained rock in which the plagioclase is white. Along portions of the contacts and in apophyses, the rock is fine grained, often inequigranular, and possesses colors ranging from grayish green to dark bottle green. This last phase very closely resembles meta-andesites of the Nosoni and Dekkas formations which are cut by the Redding dike and its apophyses, hence care must be used in the field in properly determining the relations.

Examination of thin sections of typical specimens show andesine, chloritized diopsidic augite, and interstitial quartz as the chief constituents. As accessories, magnetite, apatite, and zircon were present in all sections examined, while green hornblende, almost completely chloritized biotite, and ilmenite are present in certain sections.

Alteration products of the ferromagnesian minerals are chlorite, epidote, zoisite, and calcite; of plagioclase, calcite, zoisite, and serpentine. Most sections examined show extensive alternation.

A fine-grained phase from a five-foot dike cutting the McCloud limestone on the north side of Potter Creek canyon is composed of andesine, quartz, chloritized augite, magnetite, and additional secondary minerals, zoisite, epidote, and calcite. The texture is porphyritic with plagioclase the phenocrystic mineral. In many of the small offshoots, augite also appears as phenocrysts.

2. *Hypabyssal intrusives*

a. *Chonoliths of soda granite porphyry* (alaskite porphyry)

The largest hypabyssal bodies of probable Nevadan age are two chonoliths of soda granite porphyry, one of which, the Balaklala chonolith, forms the main mass of the ridge extending from Iron Mountain for some distance north of Behemotash Mountain west of the Sacramento River, and the other, the Bully Hill chonolith, is exposed along the lower slopes of Horse and Town mountains near Bully Hill north of the Pit River. A large area of the second body is exposed in the hilly and mountainous country in the eastern part of the Redding quadrangle south of the Pit River, and a small isolated mass extends for about four miles north of the Pit from near the mouth of Clikapudi Creek. A still smaller section extends from the head of Clover Creek into the Lassen quadrangle and others of more limited extent are present at various places in the eastern part of the Redding quadrangle.

Diller[38] originally described these bodies as two series of rhyolite flows and ejecta. The Balaklala mass he believed to underlie the middle Devonian Kennett formation and the Bully Hill complex to have been erupted prior to the deposition of the late Triassic Hosselkus limestone. Diller noted certain intrusive contacts but held that the masses were chiefly extrusive.

L. C. Graton,[39] during an investigation of the copper deposits in Shasta County, established the intrusive character of both bodies and this Ferguson[40] accepted in his report on the gold lodes of the Weaverville quadrangle. Graton's report describes the petrography of the rock which he calls alaskite porphyries and gives an excellent summary of their intrusive character. The writer has examined practically all of the contacts of both bodies and in no place can Graton's findings be disputed. Magnificent exposures of the contacts of the Balaklala body are visible in many places along the steep slopes of the canyons which have been carved into the eastern side of Behemotash Mountain where the main mass of the intrusive is exposed and, on the western side of this ridge, equally fine outcrops may be found. Near Winthrop, especially along the railroad cut leading to the Rising Star Mines, the intrusive character of the Bully Hill body is clearly shown, and at many other localities also similar relations are easily identified. Graton (p. 87) suggests that the intrusives may be laccolithic since "in the western districts the Kennett and Bragdon formations have been arched up by the alaskite porphyry (Balaklala body), and in the eastern districts the Pit formation has been deformed by it," though he does not consider it certain "that true laccolithic structure is present." In the writer's opinion, both masses should be classed as chonoliths rather than as laccoliths since (1) they considerably exceed the size set by Gilbert as the maximum for true laccoliths—the dimensions of the Balaklala body are about 6 by 13 miles, of the Horse and Town mountain section of the Bully Hill body 1 by 4 miles, and of the larger section in the eastern part of the quadrangle about 5 by 9 miles; (2) they are irregular in shape; (3) while their contacts are concordant in part, the principal stretches are distinctly discordant; and (4) considerable lengths of contact of the Balaklala body are against essentially massive igneous rock.

The rock composing the two chonoliths normally possesses a porphyritic texture with phenocrysts of quartz and feldspar or of feldspar alone in a predominant, fine-textured groundmass; along certain contacts and also within the bodies are areas of dense, fine-grained rock. The Bully Hill rock generally has a dark gray groundmass while that from the Balaklala body ranges from dark gray to pale green or greenish-gray. The porphyries vary considerably in appearance from place to place. Where the Balaklala porphyry adjoins the Mule Mountain quartz diorite stock, the texture becomes exceedingly coarse and a gradual transition between the rock types of the two bodies exists so that a definite boundary between the two can not be located. On the map, the approximate boundary is indicated by the dotted line but the pattern does not show the transitional nature of this contact. Auto-brecciated zones are present at a number of places and probably are the phases which Diller interpreted as pyroclastics. Some of the chief variations in these chonolith rocks have been produced by shearing, which is a conspicuous feature in both bodies though probably is more pronounced in the Balaklala chonolith. Along the shear zones the porphyry takes on a schistose structure and in many places has gone over to a highly foliated quartz sericite schist.

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[38] Diller, J. S., The Redding Folio No. 138, pp. 7, 8, 1906.

[39] Graton, L. C., The Occurrence of Copper in Shasta County, California. U. S. Geol. Surv., Bull. 430, pp. 82-83, 1910.

[40] Ferguson, H. S., Gold Lodes of the Weaverville quadrangle. U. S. Geol. Surv., Bull. 540, p. 30, 1914.

At the surface in most places, weathering has bleached the rocks to various shades of pink, red, yellow, brown, gray and green. The porphyries weather easily and altered rock extends scores of feet below the surface. In general the porphyries weather much more easily than any of the rocks which they intrude. This contrast is well shown between the Balaklala rock and the Copley meta-andesite which it intrudes in exploratory tunnels driven by U. S. Army Engineers during investigations connected with the possible location of a dam across the Sacramento River a few miles south of Kennett. The oxidized zone in the Copley meta-andesite rarely extends more than five or ten feet below the surface while in a tunnel which went into the Balaklala porphyry at least 150 feet below the surface, that rock was completely altered. How far below the tunnel floor completely or partially altered rock extends is not known. Deep alteration of the porphyries by meteoric waters is shown in the many mines in both the Balaklala and Bully Hill chonoliths.

The microscope shows phenocrysts of quartz, albite, and rarely oligoclase-albite are generally of small size though in a few places they may attain a diameter of one-quarter of an inch or even more; in such places the groundmass also commonly increases in coarseness. The fine-grained groundmass consists of a microgranular mixture of quartz and feldspar. Fine shreddy grains of magnetite and small particles of chlorite and of epidote that were probably derived from original flakes of biotite constitute the chief accessory constituents, but are nowhere present in important amounts. Apatite, titanite, and zircon exist sparingly as small crystals.

One of the specially striking lines of evidence proving that the porphyries are intrusive is the contact metamorphism of both the Devonian Kennett and Triassic Pit shales. At many localities these shales have been highly indurated and converted into dense hornfels, or they have been rendered porous and slaggy by the intense heat of the invading bodies. On the steep, western slopes of the Sacramento Canyon, contact effects of the first type have been developed in the Kennett shales and north of Winthrop at Bully Hill is a splendid exposure of slaggy Pit shale which has been changed from the normal dark gray to a dark brick red color. Studies of mineralogical and structural changes in the shales so far have not been made.

b. *Dikes, sheets, and other small bodies*

Great numbers of dikes, sills, and small irregular bodies of intrusive rock are present in the vicinity of the larger plutonic and hypabyssal bodies and undoubtedly represent offshoots from them. Isolated intrusions at some distance from any major bodies are composed of similar rocks and doubtless were injected into the crust at the same time. The dikes and sills occur alone or in groups or swarms. Within the stocks and bosses are many pegmatite and aplite dikes, which have already been described; the pegmatites in many places pass over into veins composed almost wholly of quartz. In color, texture, and mineral composition, the satellitic bodies exhibit a wide range. The principal petrographic types are quartz diorite, granodiorite, quartz augite diorite, soda granite porphyry, dacite porphyry, diorite porphyry, andesite, basalt, and lamprophyre. For brief petrographic descriptions of some of the types, the reader is referred to published reports by Diller,[41] MacDonald,[42] and Ferguson.[43] Further data will be presented in a later report by the writer on the Weaverville quadrangle.

Contact metamorphism about the larger Nevadan intrusives

About the various Nevadan plutonic intrusives and the two granite porphyry chonoliths, metamorphic zones and aureoles have been developed and in many places are magnificently exposed; particularly fine contacts are to be observed between the Nevadan Redding dike and the McCloud limestone and between Nevadan granodiorite and quartz diorite stocks and various rocks in the deeply glaciated sections of the interior Klamath. Because of the wide variety of rock types invaded by the various magmas, many different suites of metamorphic rocks and minerals are present, and unusual opportunity is offered for the field study of manifold contact phenomena. Profound metamorphism about igneous contacts has occurred in the limestones, especially the Permian McCloud, the Mississippian Bragdon shales, the Copley meta-andesite, the serpentines, and in a few places the Salmon and Abrams schists. The best developed and widest aureole surrounds the Shasta Bully batholith, the largest Nevadan plutonic body in the area described, but even more striking metamorphism has been produced in the McCloud limestone by the Redding quartz augite diorite dike. Moderately wide contact metamorphic zones, developed at a higher level in the earth's crust and therefore of different type, are present along the contacts between the Balaklala and Bully Hill granite porphyry chonoliths and the Devonian and Triassic shales respectively. About most of the stocks more or less conspicuous zones also are present.

THE SUPERJACENT FORMATIONS

All the formations previously described were strongly folded in the later part of Jurassic time and subsequently were deeply eroded. Upon this deformed and dissected crust lie the supercuit strata of Cretaceous and Cenozoic ages.

Post Nevadan Upper Jurrassic

Knoxville formation

The strata immediately overlying the subjacent complex in the area mapped have been divided into three important geologic units, the Knoxville at the base, the Horsetown, and the Chico. By some authorities (Becker, C. A. White, Whitney, J. P. Smith, F. M. Anderson, B. L. Clark, and others), the Knoxville has been considered partly or wholly Upper Jurassic. Many years ago, Diller and Stanton[43a] studied a section along Elder Creek in Tehama County south of the area under discussion, and divided it as follows:

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[41] Diller, J. S., *op. cit.*, pp. 7-9.

[42] McDonald, D. F., Notes on the Gold Lodes of the Carrville District, of Trinity County, California, U. S. Geol. Surv., Bull. 530, pp. 11-13, 1912.

[43] Ferguson, H. S., *op. cit.*, pp. 30-33.

Upper Cretaceous—Chico formation		4,000 feet
Lower Cretaceous	Horsetown formation	6,000 feet
	Knoxville formation	20,000 feet

Others have followed the lead of Diller and Stanton in classifying the entire section as Upper Cretaceous, and this usage has been accepted by the United States Geological Survey.[43b]

F. M. Anderson, an early student of these deposits, has recently reviewed their field relations and their paleontology, and has concluded from stratigraphic and faunal evidence that the thickness of the Knoxville must be considerably reduced, that the formation is Upper Jurassic, and that an important unconformity separates it from the overlying Cretaceous. The Cretaceous, including many thousands of feet of beds formerly classed as Knoxville, he divides into the Lower Cretaceous Shasta series, composed of the Paskenta and Horsetown formations, and the Upper Cretaceous Chico formation. The following data from a section studied near Paskenta in Tehama County have been kindly furnished by Dr. Anderson;[43c] his detailed findings will shortly appear in printed form.

Upper Cretaceous—Chico formation		4,000 feet
Lower Cretaceous		
Shasta series	Horsetown formation	7,660 feet
	Paskenta formation	4,880 feet
Unconformity		
Upper Jurassic—Knoxville formation		14,280 feet

In the area covered by the present report, the boundaries between the Knoxville and Paskenta formations and between the Paskenta and Horsetown formations have not yet been determined. According to Anderson, the Knoxville north of Paskenta is progressively overlapped by the Horsetown so that its exposed thickness is rapidly decreased. Whether true Knoxville lies in contact with the Klamath subjacent complex in the northwestern part of the Sacramento Valley is not yet known, but there is a considerable thickness of strata closely resembling those of the Knoxville farther south which the writer tentatively correlates with that formation. No fossils have been found to aid in their identification. Both horizons of the Shasta series, the Paskenta and the Horsetown, have been recognized, and each is represented by many thousands of feet of strata.

Below the lowermost Shasta strata in the northwestern part of the Red Bluff quadrangle, mostly south of the Redding-Platina road, is an undetermined thickness of conglomerate, sandstone, and shales which resemble the Knoxville of the type section farther to the south. No fossils have been found in these rocks, hence their correlation with the

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[43a] Diller, J. S., and Stanton, T. W., Shasta Chico Series, Bull. Geol. Soc. Amer., vol. 5, pp. 438–422, 1894.

[43b] Wilmarth, M. Grace, Names and Definitions of the Geologic Units of California, U. S. Geol. Surv., Bull. 826, p. 39, 1931.

[43c] Anderson, F. M., Personal communication.

Knoxville except on similarity of lithology has not been established, but the existence of a considerable thickness of strata below the lowest Shasta horizon yet discovered is strongly indicative of Knoxville age. At the base of this sequence are local conglomerate lenses composed of boulders and pebbles derived from adjacent bedrock, beds of lignite and lignitic shale which lie close to the base and below some of the thickest of conglomerates. Above are gray shales and some brown sandstones. These strata are not found in either the Red Bluff or the Weaverville quadrangles. They lie with strong unconformity on the eroded edges of the subjacent series.

Cretaceous

Shasta series. Paskenta and Horsetown formations.

In the Weaverville quadrangle, the Paskenta division of the Lower Cretaceous Shasta series is exposed along Brown and Redding creeks about 5 miles southeast of Douglas City and also in the southwest corner on the western slope of Hayfork Mountain. In the Brown and Redding Creek area, about 1,100 feet of strata overlie the Abrams schist and dip sharply to the south. The basal third is composed chiefly of medium- to fine-grained, buff, firmly cemented, arkosic sandstone with occasional layers of conglomerate and gray shale. The upper two-thirds consist chiefly of dark gray shale with thin beds of sandstone and conglomerate. Fossils, which are rather abundant in the sandstones, are considered by F. M. Anderson[43d] to belong to the middle portion of the Paskenta.

In the Red Bluff quadrangle, a great thickness of Shasta strata overlies the Subjacent complex, and is separated from it by a pronounced erosional and angular unconformity. The stratigraphy of the Shasta series in this region is only partially known; neither the base nor the top of the Paskenta have been determined. The separation between the Horsetown and the Upper Cretaceous Chico formation has been established. On the geological map accompanying this report, the Lower Cretaceous in the Red Bluff and Weaverville quadrangles is designated as Shasta.

The Shasta series generally consists of a basal conglomerate composed of pebbles and boulders of the adjacent bedrock, coarse arkose, brownish and greenish, commonly arkosic sandstones varying in texture from coarse to fine, and dark gray shales; the arkose and sandstones for the most part are present in the lower part of the formation above the basal conglomerate, but are also found throughout the formation. In the principal area in the Weaverville quadrangle on Brown and Redding creeks, brown sandstone unconformably overlies the Abrams schist and is succeeded by dark gray shales which comprise the upper two-thirds. The thickness of this exposure is about 1000 feet. In the Red Bluff quadrangle the base of the Shasta series has not been determined, though recently discovered fossils by F. M. Anderson and R. Dana Russell show that the base is several thousand feet below that set by Diller and Stanton. Thus the total thickness of the Horsetown in the Red Bluff quadrangle is not known, but probably is more than 6000 feet.

[43d] Anderson, F. M., Personal communication.

From a short distance west of Igo in the Weaverville quadrangle to Jerusalem Creek in the Red Bluff quadrangle (a distance of eight miles) the Horsetown division overlies the Shasta Bally quartz diorite batholith. At the base, the Horsetown is composed of medium gray, massive coarse-grained, fresh arkose composed of plagioclase, quartz, biotite, and hornblende in about the same proportions as in the quartz diorite. Poorly preserved fossils are present at a few horizons in this arkose. Locally conglomerate, composed chiefly of quartz diorite pebbles and boulders with lesser numbers from the other subjacent formations, is present at the base or at higher horizons interbedded with the arkose. Above the main arkoses and conglomerates are greenish and brownish arkosic sandstones commonly containing much biotite, and these in turn are succeeded by gray shales with occasional sandstones and conglomerates. Some zones are highly fossiliferous. This section is Upper Horsetown.

At Byron Gulch, where Byron Stream joins the North Fork of Cottonwood Creek a lower section of the formation is exposed. At the base is a conglomerate ranging from 250 to 300 feet thick, which is poorly sorted and is composed of pebbles and boulders some of which are more than two feet in diameter. The pebbles and boulders are composed of rocks from various subjacent formations such as the Shasta Bally quartz diorite, Bragdon conglomerates and slate, Copley meta-andesite, and various other igneous rocks. Above are massive sandstones with occasional shaly interbeds, interbedded sandstones and shales, sandy shales, and finally dark gray, nodular, carbonaceous shales. Intraformational conglomerates, fine- and coarse-grained sandstones containing shale fragments are present at various horizons in the dominantly shaly upper part of this section. Fossiliferous zones are numerous.

Chico formation

The Chico formation is widely exposed in the Redding quadrangle along the southern Klamath foothills which it partially buries; it does not show in the Weaverville area. It overlies the subjacent series with strong angular and erosional unconformity, and dips at angles of less than twenty degrees to the south or southwest. At the base there is generally a rather coarse to very coarse conglomerate composed principally of rounded and subangular boulders of the subjacent formations immediately underneath; where the Chico is in contact with the Triassic, the conglomerate consists of generally sharply angular fragments of the slates. Thus the character of the boulder beds varies along the strike depending on the nature of the bedrock. The size of the boulders in the basal conglomerate also vary from place to place; most do not exceed eight inches in maximum diameter, though occasional boulders are two feet or more across. Above are coarse, arkosic, firmly cemented sandstones, general yellowish or brownish in color, and contain considerable volumes of dark mineral and rock fragments; these are succeeded by finer-textured sandstone of same composition. Shales and sandy shales, some of which are carbonaceous or even lignitic, are interstratified with sandstone. Most of the sandstones are massive and thick bedded; but some exhibit moderately thin layering. Clay ironstone concretions of dark brown color are commonly present; these either stand out from the surface or have been removed leaving pits. The sandstones become more or less abundant and shaly in the upper portion of the formation which, in the central part of the quadrangle, is composed of gray shales generally containing clay ironstone concretions. On the eastern side of the Sacramento Valley in the Redding quadrangle, at the top of the Chico are brown, arkosic sandstones and conglomerates in which some boulders reach four feet in diameter.

The principal exposures of the Chico are in the eastern part of the Redding quadrangle along South Cow Creek, Old Cow Creek, Basin Hollow Creek, Clover Creek, Oak Run and Swede Creek. A small area is located near Oak Flat and one of much larger extent north of Frazier Corners. Another extensive area is crossed by the Pacific Highway about five miles north of Redding. Smaller patches are present in the extreme southwest corner of the quadrangle.

Splendidly preserved fossils are found abundantly in the basal sandstones and conglomerates, in moderate quantities in the shales, and commonly in the upper sandstone and conglomerates. These fossils are of Upper Cretaceous age and belong to the middle part of the Chico epoch. Gastropods are most numerous, followed by pelecypods, and cephalopods. A large fauna is present, but unfortunately has not been described in detail.

The following is a section of the Chico formation measured along Dry Creek north of Frazier Corners in the south central part of the Redding quadrangle:

Red Bluff gravels (Pleistocene).

Angular and erosional unconformity.	Feet
7. Gray shale, weathering lighter gray or brown on surface and containing abundant clay iron concretions. Thin interbeds of brown, arkosic sandstone.	40
6. Gray shales similar to above with frequent interbedded brown, arkosic sandstones.	209
5. Fine-grained, brown, arkosic sandstones with interbeds of gray shale.	56
4. Massive brown, medium grained, arkosic sandstones with gravelly interbeds. Contain round, ferruginous concretions.	70
3. Massive, brown, fine-grained arkosic sandstone. A few interbeds of shale and shaly sandstone some of which is lignitic.	183
2. Massive, coarse-grained, brown arkosic sandstone with occasional shaly interbeds.	52
1. Massive, coarse-grained brown, arkosic sandstones and interbedded conglomerates. At base, conglomerate composed of generally angular fragments of Triassic state.	40

Angular and erosional unconformity.

Triassic
  Pit formation

Tertiary

Eocene

Montgomery Creek formation

Along the southeast slopes of the Klamath Mountains in Kosk Creek and Pit River canyons, farther to the south on Montgomery Creek, and at a few other localities is a series of dominantly fluviatile brownish, arkosic sandstone, sandy shales, and conglomerates which Diller[44] in the Redding Folio called the "Ione" formation and dated Miocene on the basis of determination of fossil leaves made by Knowlton. These strata have been recently examined by R. Dana Russell[45] who was associated with me in the geologic studies of the southern Klamath Mountains and will be described by him as the Montgomery Creek formation in a report now in preparation. Determination by R. W. Chaney of a flora discovered by Russell indicates a later Middle Eocene age for the formation and Russell's field and laboratory studies prove that the formation is not the Ione formation as Allen[46] has recently redefined it along the eastern margin of the Great Valley.

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[44] Diller, J. S., *op. cit.*, p. 6.

The sediments appear to have come from the east and northeast but the actual source is not known since most of the area covered by these Eocene deposits was later flooded by Columbia-Cascade lavas and pyroclastics. The detritus does not resemble bed-rock types of the Klamath Mountain complex.

Only a limited area of this formation appears along the eastern margin of the Redding quadrangle south of Little Cow Creek. Most of the strata which Diller mapped as Ione belong to the Pliocene Tuscan and Tehama formations.

Weaverville formation

Diller,[47] Hershey[48] and MacDonald[49] have described deposits of "auriferous gravels" from a number of small basins in the western Klamath Mountains; the principal areas are located at and near

Weaverville and Shasta Quadrangles	1. Trinity Center and Carrville
	2. Lowden and Lewiston, along the Trinity River
	3. Weaverville
	4. Browns Mountain
	5. Dutton Creek
	6. Redding and Indian Creeks
Big Bar Quadrangle	7. Hayfork
	8. Hyampom

Under this heading of "auriferous or gold gravels," deposits of such different ages and types are included that the term has no stratigraphic significance. The earliest or first cycle group, for example, are the Cretaceous marine conglomerates which at certain localities contain detrital gold. The second series includes fine-textured flood plain sediments (sandstone, shaly sandstones, and sandy shales), lake beds, lignitic shales and lignites, tuffs, and coarse stream gravels. The fossil plants present toward the base of the series at various localities are of Eocene age, but whether all of the beds belong to a single sequence has not been determined. For this series of beds the writer proposes the name Weaverville formation from the extensive exposures near Weaverville, county seat of Trinity County. The gravels most important as a source of gold are coarse channel deposits of

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[45] Russell, R. Dana, Personal communication.

[46] Allen, V. T., The Ione Formation of California, Univ. Calif. Publ., Bull. Dept. Geol. Sci., vol. 18, pp. 337–448, 1929.

[47] Diller, J. S., Topographic Revolution in the Topography of the Pacific Coast: U. S. Geol. Surv., 14th Ann. Rept., p. 419, 1894. The Auriferous Gravels of the Trinity River Basin: U. S. Geol. Surv., Bull. 460, pp. 11-29, 1911. Auriferous Gravels in the Weaverville Quadrangle: U. S. Geol. Surv., Bull. 540, pp. 11-21, 1914.

[48] Hershey, O. H., The Sierran Valleys of the Klamath Region: Jour. Geol., vol. 11, p. 157, 1903.

[49] MacDonald, D. F., The Weaverville-Trinity Center Gold Gravels, Trinity County, California: U. S. Geol. Surv., Bull. 430, pp. 48-58, 1910.

Pleistocene age and similar sediments now being laid down by present streams.

The deposits of the second cycle have been preserved by the downfaulting of small blocks into the much more resistent bedrock of the region, and in these basins the soft, unconsolidated sediments were protected from rapid erosion.

The principal deposit extends from a short distance south of Weaverville for about twenty miles to the north northeast and has a width of one to three miles. Next in size are the exposures along Hayfork stream at Hayfork and Hyampom in the Big Bar quadrangle, and on Indian and Redding creeks 10 miles southeast of Douglas City in the Weaverville quadrangle. The areas on Browns Mountain, along the highway two and one-half miles north of Lowden, along the Trinity River near Lowden, and on Dutton Creek southwest of Weaverville are much smaller. The deposits are composed chiefly of loose or slightly consolidated boulders, gravels, sands, and clays. Carbonaceous clays and sand and occasional seams of low grade lignite also are present. On Redding Creek and in the Hayfork and Hyampom basins, tuffs and tuffaceous sediments are present in considerable volume; tuffaceous sediments occur at Weaverville, Brown's Mountain, Dutton Creek, and the Lowden-Lewiston area. A section measured by Diller at this locality is given:

Redding Creek

Partly cemented gravels	400 feet
Tuff and tuffaceous sediments	250 feet
In the upper part a 50-foot bed of gravel.	
Shale, thin beds of tuff and a bed of shaly coal 5 to 15 feet thick	250 feet
Erosional and angular unconformity.	
Paskenta Lower Cretaceous and Subjacent Series.	

Data regarding the other areas in which the Weaverville beds are found are contained in a report on The Auriferous Gravels of the Trinity River Basin, California, U. S. Geological Survey, Bulletin 470, pp. 11–29, 1911.

Plants found in the tuff and tuffaceous sediments on Redding Creek and near Hayfork and Hyampom were considered by the late F. H. Knowlton to be of Miocene age and to be equivalent to the fossil floras of the Sierra Nevadan auriferous gravels. According to Mr. Harry MacGinitie,[49a] who has worked on this flora under the direction of Dr. R. W. Chaney, the fossil plants are of Eocene age, and probably are to be correlated with the floras of the auriferous gravels of the Sierra Nevada.

Pliocene

Tuscan formation

One of the important superjacent formations which has been accumulated over the southeastern slopes of the Klamath Mountains and which extends for many miles down the east side of the Sacramento Valley is the huge pile of fragmental volcanics and interbedded sediments, which Diller[50] named the Tuscan formation. This sequence is composed largely of andesitic and basaltic fragments together with occasional dacitic tuffs. Agglomerates and tuffs are the chief constituents, while of subordinate importance are interbedded gravels, sands and sandy clays, which are products resulting from the reworking of the volcanic accumulations by streams. Diller believed the rocks to be largely hypersthene andesite with minor quantities of hornblende andesite and basalt, but Dr. C. A. Anderson of the University of California, who is making a detailed study of the Tuscan formation, states[51] that basaltic fragments are present in much larger quantities than Diller supposed.

[49a] MacGinitie, H., Personal communication.

[50] Diller, J. S., Lassen Peak Folio (No. 15), preliminary ed., U. S. Geol. Surv., 1892.

The chief members of the Tuscan are thick mud-flows which spread over a large area extending principally to the west of the present site of Lassen Peak. To the east their distribution is obscured by a covering of later volcanics. In their advance to the north and west, the mud-flow spread over an erosion surface cut in Eocene and Cretaceous strata and finally reached and buried a part of the low foothills of the southeastern Klamath Mountains. When this volcanic epoch had closed, a great undulating table land had been developed to the southwest of the Klamath Mountains. Subsequently streams deeply eroded the plateau and stripped large volumes of the deposit from the underlying rocks. To the east, later volcanism buried this Tuscan landscape beneath lava flows and the products of explosive eruptions. None the less over large areas, tabular remnants of this mud-flow plateau are exposed and are characterized by a bouldery surface apparently developed by the removal of the finer detritus.

In Tehama County the Tuscan formation is at least 1000 feet thick but along the southeastern slopes of the Klamath in the Redding quadrangle, the mud-flows thin out and generally less than 100 feet are preserved. The formation thickens rapidly from the west towards its source. The nature and the exact location of the eruptive centers are unknown, but they are believed to have been located in the general vicinity of the present Lassen Peak.

Tehama formation

R. Dana Russell[52] has recently defined under the name of the Tehama formation a series of beds abutting the southern Klamath foothills and extending far to the south in the Great Valley, which previously had not been recognized as a definite stratigraphic unit. This formation consists of about "2000 feet of massive, pale greenish gray to pale buff silty sands, sandy silts and clays which are usually tuffaceous; intercalations of sand and gravel, often strongly cross bedded, are present throughout. A massive coarse grained pumice tuff member (called by Russell the Nomlaki tuff) is interbedded about 700 feet above the base. This is of dacitic composition and consists of white pumice fragments embedded in a medium to light gray matrix of glass and crystal shards. Most of the pumice fragments are less than three inches in maximum diameter but they occasionally exceed one foot. The upper six feet of the tuff often has a salmon pink color in marked contrast to the predominant gray below. The tuff is variable in thickness; in Tehama County the maximum is fifty feet. On the eastern side of the Sacramento Valley a maximum of 300 feet was measured."[53] Fine exposures are located near Millville in the southeastern part of the Redding quadrangle where the rock was quarried for building stone. The Tehama beds are rather widely distributed in the southern part of the Redding quadrangle where they lie unconformably on the Chico Cretaceous. No exposures have been observed in the Weaverville or the mapped portion of the Red Bluff quadrangle.

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[51] Anderson, C. A., Personal communication.

[52] Russell, R. D., and Vander Hoof, V. L., A Vertebrate Fauna from a New Pliocene Formation in Northern California: Univ. Calif. Publ., Bull. Dept. Geol. Sci., vol. 20, pp. 11-17, 1931.

In 1894 Diller[54] included in the Tuscan formation the Nomlaki dacite pumice tuff above referred to and thus greatly increased the area supposed to be covered by the Tuscan. The Nomlaki tuff is present near the base of the Tuscan formation at a number of localities on the eastern side of the Sacramento Valley. Russell[55] considers that it should be separated from the Tuscan because "of its highly distinctive appearance, dacitic composition in contrast with the andesitic composition of the Tuscan, much wider distribution, and value as a horizon marker." He therefore proposes for it the name Nomlaki tuff from the Nomlaki Indian Reservation in Tehama County where it is well exposed.

From various lines of evidence, Russell holds that the Tuscan and Tehama are contemporaneous formations. Stratigraphic data suggest that both probably are Pliocene and a vertebrate fauna collected near the base of the Tehama and above the Nomlaki tuff has proved to be upper Middle or Upper Pliocene in age. The two vertebrate horizons so far recognized are at 10 and 200 feet above the top of the Nomlaki tuff.

Evidently in Pliocene time eruptions of dacitic magma took place in the vicinity of the present Lassen Peak and the pumiceous fragments were swept far and wide over the Sacramento Valley by the fearful violence of the eruptions. The various deposits accumulated one over the other with no evidence of an important break between. The character of the eruptions suggests that probably the whole of the flood plain was not covered but considerable areas were so blanketed and a special type of initial volcanic surface was developed. This was volcanic in origin but different from the volcanic surface of the Tuscan which had started to form before and continued its construction long after the deposition of the Nomlaki tuff. Thus the andesite eruptions of the Pliocene in this region were much longer continued than the dacite, but apparently did not cover so large an area. After the cessation of the Nomlaki volcanism, andesite mudflows and sediments derived from them continued to form in the Tuscan area on the east side of the Great Valley, while on the floor of the Pliocene Great Valley flood plain sediments accumulated over the surface of the Nomlaki tuff to a depth of more than 1200 feet.

The Nomlaki outbursts represent a volcanic episode of comparatively short duration but of excessive violence. Beds of fine vitric tuff are present in the Tehama formation above the Nomlaki tuff but their compositions are not known. They show, however, that explosive eruptions recurred on a lesser scale in later Tehama time.

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[53] Russell, R. D., Thesis summary. Univ. of Calif., 1931.

[54] Diller, J. S., Tertiary Revolution in the Topography of the Pacific Coast: U. S. Geol. Surv., 14th Ann. Rept., pt. II, p. 411, 1894.

[55] Russell, R. D., and Vander Hoof, V. L., loc. cit., p. 14.

Tertiary and Pleistocene lavas

In two areas, pyroxene-andesite and basalt flows of probable Pleistocene age are present:

1. At various places in the canyons of the Klamath and Siskiyou Mountains are remnants of narrow terraces cut by streams during a brief epoch of temporary base-leveling during the Cenozoic. Subsequent rejuvenation, apparently resulting from a regional elevation of the crust, has caused the streams to incise new gorges 50 to 100 feet below the terrace levels. Such a cut terrace is finely developed in the Little Sacramento Canyon; between the junction of Sugarloaf Creek and the Sacramento River, the terrace is capped in places by one, and in places by two flows of basalt which, according to Diller[56] "escaped from a vent surmounted by a cinder cone on the southern slope of Mt. Shasta, and, getting into the narrow valley of the river, followed it until the flow ceased and the lava congealed." Diller mentions only one flow, but below this is an older, less conspicuous, and more deeply weathered lava tongue which lies on the Sacramento terrace. After the second flow had solidified, the Sacramento ran over its surface for a time, and deposited upon it a considerable thickness of coarse gravels. Later, following the elevation previously referred to, the river cut the narrow gorge in which it now flows through the lavas and into the underlying bedrock.

Diller classed the flow described by him as andesite, but the plagioclase both of phenocrysts and groundmass is basic labradorite hence the rock is basalt. The flows are medium to dark gray in color and exhibit prominent porphyritic textures. Practically all of the phenocrysts are feldspars which show rude parallel arrangement. The plagioclase composes about half of the rock. Small grains of augite are just visible in hand specimens and are practically confined to the groundmass. Hypersthene and olivine are minor constituents. The ferromagnesian minerals compose about thirty per cent of the bulk of the rock. Brown glass, containing abundant small magnetite cubes, composes the residue.

2. Abutting the southeastern slopes of the Klamath Mountains and burying much of the post-Jurassic sediments and volcanics deposited over their lower foothills are flows of pyroxene andesite and basalt of Tertiary and Pleistocene ages. Near Kosk Creek and Pit River these lavas apparently belong to the Tertiary Cascade-Columbia sequence, but farther west the surface flows are more recent since locally they overlie the late Pliocene Tuscan formation. Unfortunately the history of this great lava covered region of northeastern California is little known. In the Tertiary and Pleistocene, great volumes of basic lava were erupted from fissures and from central vents and at certain centers through the entire region. Locally this activity has continued till very recent time; Lassen Peak is still active and it is impossible to say that the younger volcanoes and even some of the more eroded ones are extinct.

Splendid sections of the volcanics along their junction with the Klamath Mountains are to be found in the canyons of the Pit River and its tributaries east of Kosk Creek. These canyons are the deepest of any crossing the lavas and consequently should yield specially vital evidence in working out the history of the region. In the low hilly and mountainous country of the southeastern part of the Redding quadrangle, these lavas form caps on the broad divides between the streams.

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[56] Diller, J. S., Redding Folio, U. S. Geol. Surv., No. 138, p. 9, 1906.

The writer has not made petrographic studies of any of the probable Tertiary lavas but field examinations show that they are largely pyroxene andesite and basalts. Sediments, including diatomites, are interbedded with the flows. Little pyroclastic material is present in the sections which I have seen.

The later flows of probable Pleistocene age are chiefly pyroxene andesites which have come from fissures and vents in the Lassen volcanic area though not from Lassen Peak itself. Adjacent to the Klamath Mountains, no pyroclastics are present.

Quaternary

Pleistocene gravels

1. Red Bluff gravels of the Redding quadrangle

In the lowlands adjacent to the Klamath Mountains in the Redding quadrangle is a series of unconsolidated and poorly assorted gravels, sands, and occasional lenses of clay called the Red Bluff formation from fine exposures along the Sacramento River near the town of Red Bluff in Tehama County (Red Bluff quadrangle). The exposures are commonly reddish in color. These gravels extend in discontinuous areas up the principal canyons, notably that of the Sacramento. The deposit is composed principally of coarse detritus in which gravel, pebbles, and boulders predominate. The boulders, rounded or subangular, in many cases exceed a foot in diameter and some more or less angular boulders reach four and five feet. Numerous sandstone lenses and also occasional small lenses of shaly sand are present. The deposit is about 50 feet in thickness and overlies all of the earlier formations. It caps the old erosion surface extending from the foot of the Klamath Mountains southward to the margin of the Redding quadrangle. The deposit according to Diller is at least 100 feet thick along the Sacramento River near Redding but R. Dana Russell has shown that most of this cliff is cut in the Pliocene Tehama formation over which the Red Bluff forms a thin veneer. Remnants of gravels apparently once either continuous or nearly continuous with the Red Bluff of the plains are found at various localities in the Sacramento canyon. The texture of the deposit decreases in coarseness to the south and at the type locality near Red Bluff 30 miles south of Redding sand predominates and the beds of gravel and pebbles are of less significance.

2. Klamath gravels of the Weaverville quadrangle

At many places along the various canyons of the Weaverville quadrangle are deposits of boulders, pebbles, gravel, and sand similar in appearance to the Red Bluff gravels of the Redding quadrangle but generally coarser in texture. These deposits range from about 50 to more than 100 feet in thickness and have been considerably dissected by the streams flowing down through the canyons so that much of their original extent has been destroyed. Large volumes also have been removed in washing the gravels for gold. Apparently subsequent to the formation of the gravels the region suffered elevation which caused the rejuvenation of the streams and allowed them not only to cut through the gravel deposits but also for some distance into the underlying rock. The principal areas of these gravels are located (1) along Clear Creek northwest and southeast of Whiskeytown and on the tributary Whiskey Creek north of Whiskeytown; (2) about 1 mile west of the first occurrence on Clear Creek there is a long stretch of gravels running past Tower House and French Gulch to about a mile north of Cline Gulch, a tributary of Clear Creek; (3) an extensive deposit is located in the filled basin through which the Trinity River flows north of Bragdon Gulch and this deposit extends into the East Fork of the Trinity and also into Swift Creek on the west side; (4) on the East Fork of the Trinity River north of Minersville; (5) on the Stuart Fork of the Trinity more or less continuously from the mouth of Owen Creek to a point one-half mile from Minersville Post Office; (6) in the Big Meadows of the Stuart Fork between the mouth of Deer Creek and Devil's Canyon; (7) along the Trinity River from about 2 miles north of Lewiston past the mouth of Bear Gulch; (8) a small area just south of Lewiston; (9) along the Trinity River for about 3 miles east of Douglas City; (10) on Indian Creek from the mouth of Spring Gulch to the mouth of Mule Gulch; (11) along Redding Creek south of Clements Ranch. These deposits of gravel are of much economic importance because of their content of placer gold and during the whole history of mining in the Weaverville quadrangle have been extensively mined. These gravels were apparently deposited during the Pleistocene when the streams were supplied with an exceptional amount of coarse detritus. Possibly this occurred during the waning stages of the last glaciers which were present in the higher mountains of Trinity County and adjacent regions. The coarseness of the gravels suggests their deposition under flood conditions such as should have developed during the times of melting ice. The presence of boulders of exceptional size far down the courses of the streams is suggestive of ice rafting when the streams were swollen during times of thaw. The dissection of the deposits and the cutting of the streams into the bedrock indicate that a considerable time has elapsed since their deposition. The deposits themselves of course could be quickly channeled, but the bedrock, which has been trenched to a depth of 50 to 75 feet, is everywhere composed of very resistant rock. This dissection indicates a later re-elevation of the Klamath region on a moderate scale accompanied by important rejuvenation of the streams. The gravels overlie all other formations unconformably and when their deposition closed formed long narrow flats filling the bottoms of the submature canyons. Bones of Pleistocene animals have been found in the deposits in the Weaverville quadrangle.

These gravels are continuous with the Red Bluff deposits of the Redding and Red Bluff quadrangles. Since the gravels are so widespread through the canyons of the Klamath Mountains and since the deposits are so much coarser textured than the flood plain phase at the type locality near Red Bluff, the writer proposes for them the name Klamath gravels. The Red Bluff is an accumulation over a surface of low relief deposited by sluggish streams and should be designated as the Red Bluff phase. Upstream this phase grades into the coarser Klamath type near the city of Redding.

Recent alluvium

Unconformably overlying the Red Bluff and T the Redding quadrangle and also lying on all of the st tions both superjacent and subjacent in all portions of th are deposits of gravels laid down by the present streams. In gene these are characterized by coarse boulders many of which are diameter with which is mixed finer pebbles and coarse sand. The boulders include rock types characteristic of all earlier deposits. The principal deposits in the Redding quadrangle are along the Sacramento River, Clear Creek, and the various tributaries of Cow Creek; the texture of the deposits becomes finer along the lowland courses of the streams. These gravels contain a certain amount of gold grains which have been sought for by extensive placering. In the Weaverville and Red Bluff quadrangles because of the much greater diversity of relief the stream gravels are narrow deposits along the canyon bottoms. In the Weaverville quadrangle the main area of recent alluvium is in a basin through which the Trinity River runs north of Bragdon Gulch.

ECONOMIC GEOLOGY OF PORTIONS OF DEL NORTE AND SISKIYOU COUNTIES, NORTHWESTERNMOST CALIFORNIA

JOHN H. MAXSON *

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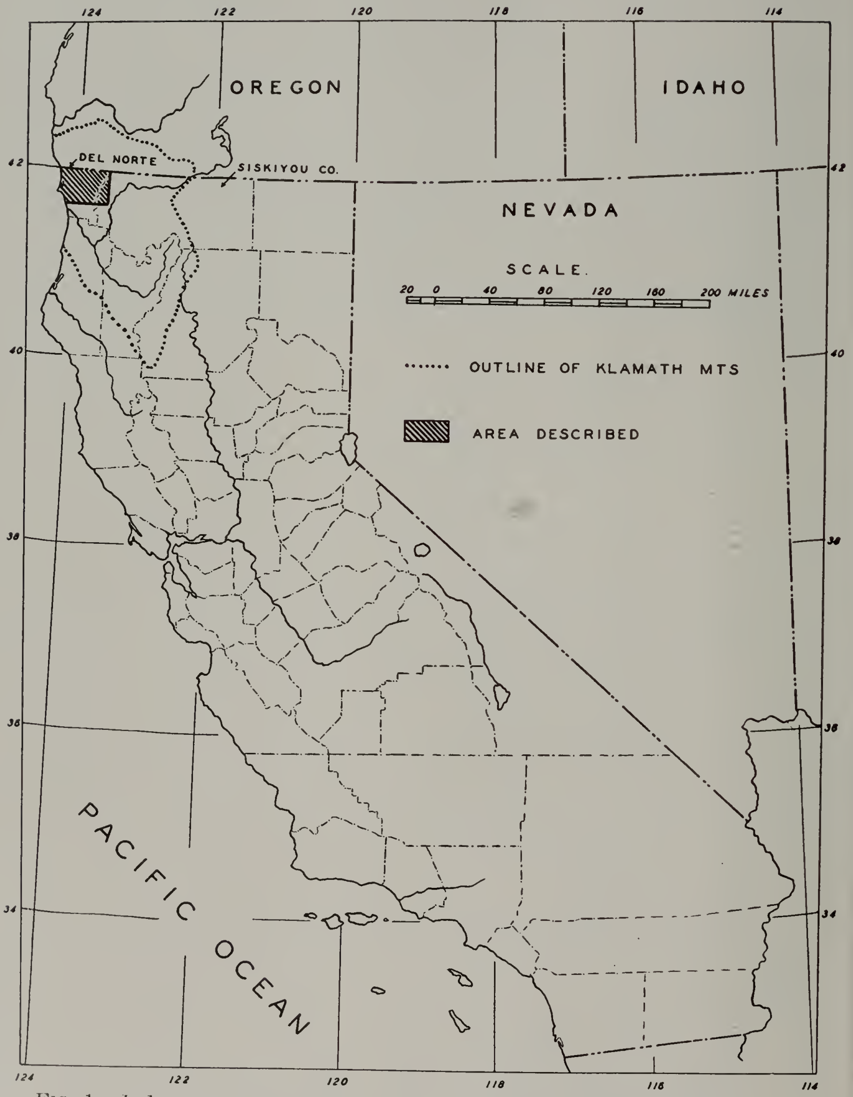
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DEL NORTE
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NEVADA
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OUTLINE OF KLAMATH MTS
AREA DESCRIBED
42
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34
PACIFIC OCEAN

FIG. 1. Index map of California showing location of area described.

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INTRODUCTION

Location

The region described in this paper occupies the extreme northwestern corner of the State of California extending inland about 36 miles from the Pacific Ocean and southward about 20 miles from the Oregon boundary. It includes the northern portion of Del Norte County and a small northwestern fraction of Siskiyou County. It is in part represented topographically on the Preston Peak quadrangle (41°30′–42° N, 123°30′–124° W), which contains the western end of the Siskiyou Range, a northwesterly member of the Klamath Mountains group.

Klamath River, the trunk stream of northern California and south central Oregon, flows through the southern portion of the area. Smith River, to the north, drains the major basin within Del Norte County.

Physical Conditions

Northwesternmost California is mountainous with some peaks attaining an elevation of over 7000 feet. The region is heavily forested, the temperate and humid climate being favorable to a multitude of plant types.

The Redwood Highway, formally completed in 1928, traverses this part of California and greatly increases its accessibility. The interior mountain area is served by a few United States Forest Service roads and by a network of trails. Here horses and pack trains are as necessary as in the earliest days of settlement.

Lack of suitable transportation facilities has impeded development of mineral resources. Products of Del Norte County are commonly carried by wagon or truck to the harbor at Crescent City, the county seat, whence they are transferred to vessels in coastwise shipping and distributed. The Redwood Highway now renders fairly accessible the Southern Pacific railroad facilities at Grants Pass, Oregon, some 66 miles by airline northeast of Crescent City.

Previous Work

The general geology of the area described in this report has almost escaped the attention of geologists. A notable exception is afforded by a very brief account of the economic geology of Del Norte County by O. H. Hershey,[1] based upon a reconnaissance made in 1907. This paper is accompanied by an areal map showing the general distribution of formations, the only one thus far published.

The physiography is in part discussed by Diller [2] in "The Topographic Development of the Klamath Mountains."

Mineral resources of the region have been described by Hershey,[3] Diller,[4] Lowell,[5] Aubury,[6] and others.[6a]

The most recent report on the mineral resources by C. McK. Laizure,[7] includes the description of a number of properties not visited by the writer.

Object of Report

The mineral deposits discussed in this report were studied in connection with a program of research in the geology of the western Siskiyou Mountains carried out under the supervision of Professor J. P. Buwalda. Most of the deposits are not being exploited at present and many have not been worked in over a decade. Some occurrences have potential economic value, depending upon market and possible improvements in transportation. The study has been made, however, not from the standpoint of a mining engineer interested in future production, reserves, ownership, etc., but rather from the scientific aspect in regard to geological setting and genesis.

SUMMARY OF GEOLOGY

The northwesternmost corner of California may be divided physiographically into three parts. Along the Pacific Ocean is the coastal province including the shoreline belt and the sub-rectangular emerged marine terrace upon which Crescent City is situated. Immediately inland is a country of plateaus and accordant ridges separated by deep canyons, a region increasing in altitude from about 1400 feet near the high sea cliffs to over 3000 feet at the western base of the Siskiyou Range proper. This region was reduced to a peneplain before late Miocene time, was locally warped and uplifted in the early to middle Pliocene, and was reduced later to a surface of low relief. Renewed uplift in the early Pleistocene initiated the present cycle. This region as a whole may be referred to as the Klamath oldland province. The third province may be termed the Siskiyou upland because it includes the mountain peak and valley topography of the western Siskiyou

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[1] Hershey, O. H., Del Norte County geology: Min. and Sci. Press, vol. 102, p. 468, 1911.

[2] Diller, J. S., Topographic development of the Klamath Mountains: U. S. Geol. Survey Bull. 196, 1902.

[3] Hershey, O. H., Black Diamond (Del Norte County, California): Min. and Sci. Press, vol. 98, p. 147, 1909.

[4] Diller, J. S., Chromite in the Klamath Mountains, California and Oregon: U. S. Geol. Survey Bull. 725-A, pp. 1–34, 1921.

[5] Lowell, F. L., Del Norte, Humboldt, Mendocino counties: Cal. State Min. Bur., Rept. XIV, pp. 373–391, 1916.

[6] Aubury, L. E., Copper resources of California: Cal. State Min. Bur., Bull. 23. pp. 97–116, 1902.

[6a] Cal. State Min. Bur., Bull. 50, pp. 133–140, 1908.

[7] Laizure, C. McK., Del Norte County: Cal. State Min. Bur., Rept. XXI, pp. 281–294, 1925.

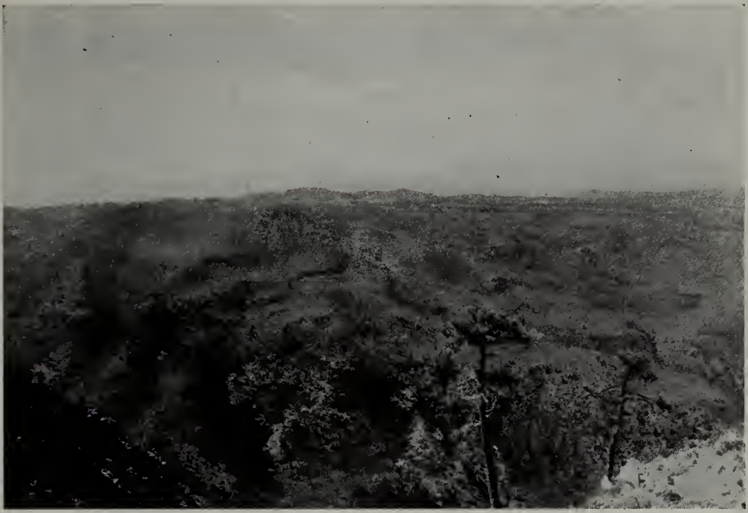

FIG. 2. Looking north at level summit of Pine Flat Mountain, a remnant of the Klamath oldland, over the gorge of the north fork of Smith River. Topographic illustration of relationship between surfaces of the former and present erosion cycles.

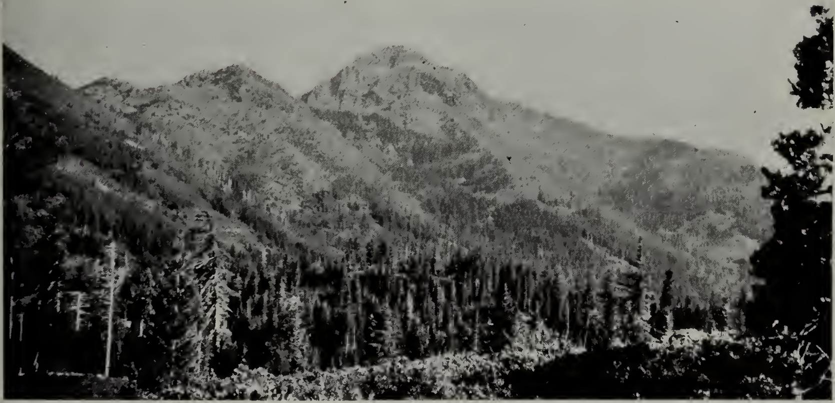

FIG. 3. Preston Peak from the north.

Range and possesses elevations up to 7310 feet above sea level (Preston Peak). The range was moderately glaciated in the Pleistocene.

The oldest formations are largely found in the Siskiyou upland and the youngest in the coastal province. The stratigraphic section is tremendously complicated and is witness to a long and varied geologic history. Igneous rocks preponderate over the entire area and include the range from rhyolite to basalt, from granite to peridotite.

Algonkian (?)

Schists

As in other parts of the Klamath Mountains, there are two general groups of schists which in the area described, however, were not observed in contact. The characteristic rock of the one group is a quartz mica schist. Hershey[8] originally described the unit as the Abrams formation and considered it pre-Cambrian. In the Port Orford quadrangle of Oregon, Diller[9] described quartz-mica schists as the Colebrooke formation. In the occurrences observed in Del Norte County quartz-mica schist is subordinate to interbedded phyllite and slate. The formation represents a dynamo-metamorphosed series of shales and argillaceous sandstones.

The second group of schists is characterized by hornblende folia separated by quartz and feldspar. Hershey[10] described this rock as the Salmon hornblende schist. From studies in the southeastern Klamath Mountains, Hinds[11] concludes that the Salmon formation represents a metamorphosed series of basic-lava flows. He has grouped the two sets of schist under the name 'Siskiyou terrane.'

In the Preston Peak quadrangle the Salmon formation occurs in isolated patches, as pendants in various intrusive masses.

Devonian

Grayback formation

This formation outcrops in the northeastern corner of the Preston Peak quadrangle where it consists of over 5000 feet of argillites, cherts, limestone (in part marble) and interbedded flows of basalt. Fossils collected by Diller[12] were determined by E. M. Kindle as representing Devonian. The formation is in some respects similar to the Kennett formation (middle Devonian) of Shasta County.

Late Paleozoic (?)

Preston diorite

The Preston hornblende diorite (named from occurrence in Preston Peak) intrudes the Grayback formation and is intruded by serpentine and by the Siskiyou granodiorite. Thus in age it may come anywhere in the great interval between Devonian and late Jurassic. While conclusive field evidence is at present lacking, the intrusion is likely to prove to be late Paleozoic in age. Certain dioritic and gabbroic intrusives to the southeast have been considered by Hinds[13] to be probably of Paleozoic age.

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[8] Hershey, O. H., Metamorphic formations of northwestern California: Am. Geologist, vol. 27, p. 225, 1901.

[9] Diller, J. S., U. S. Geol. Survey Geol. Atlas, Port Orford folio (No. 89), 1903.

[10] Hershey O. H., *op. cit.*

[11] Hinds, N. E. A., Paleozoic eruptive rocks of the southern Klamath Mountains, California: California Univ. Dep. Geology Bull., vol. 20, pp. 375–410, 1932.

[12] Diller, J. S., Mineral resources of the Grants Pass quadrangle and bordering districts, Oregon: U. S. Geol. Survey Bull. 380, pp. 50–51, 1909.

The Preston diorite is commonly a fine-grained, gray rock closely cut by quartz veinlets. Green hornblende is more characteristic than brown, though both occur. Moderately calcic plagioclase is the other important constituent. Minor amounts of quartz and orthoclase are sometimes present in granodioritic facies.

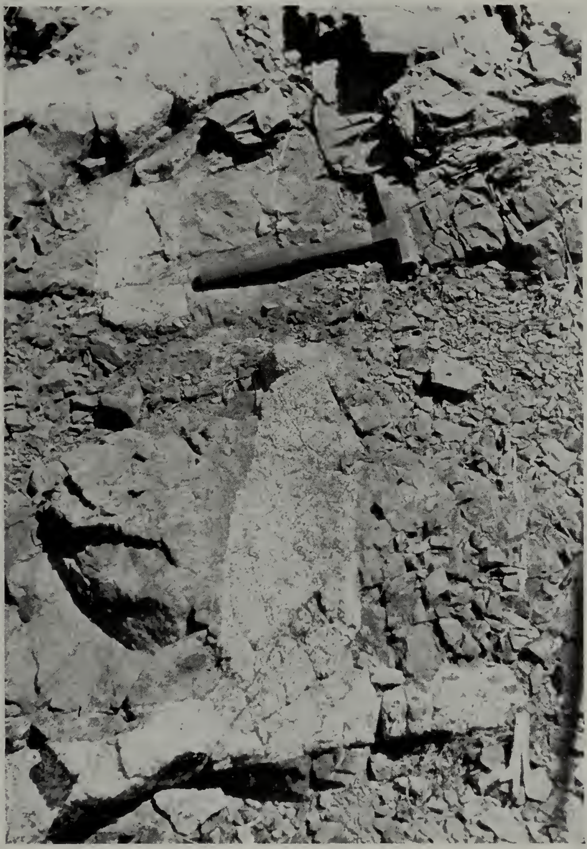

FIG. 4. Dike of Siskiyou granodiorite penetrating Preston hornblende diorite.

Jurassic

Galice formation

The Galice formation named by Diller [14] for its occurrence in southwestern Oregon consists of dynamo-metamorphosed argillites preponderantly, with associated sandstones and fine conglomerates. These are intruded in places by dikes and sills of rhyolite. Fossils collected by

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[13] Hinds, N. E. A., *op. cit.*, p. 406.

[14] Diller, J. S., The Mesozoic sediments of southwestern Oregon: Am. Jour. Sci., 4th ser., vol. 23, pp. 404–405, 1907.

Diller near the type locality indicate late Jurassic age. He regarded the formation as a correlative of the Mariposa slates of the Sierra Nevada.

Several areas of argillites and slates of doubtful correlation are shown on the map as Galice. The area represented as Grayback formation near the central portion of the map may eventually prove to be Galice.

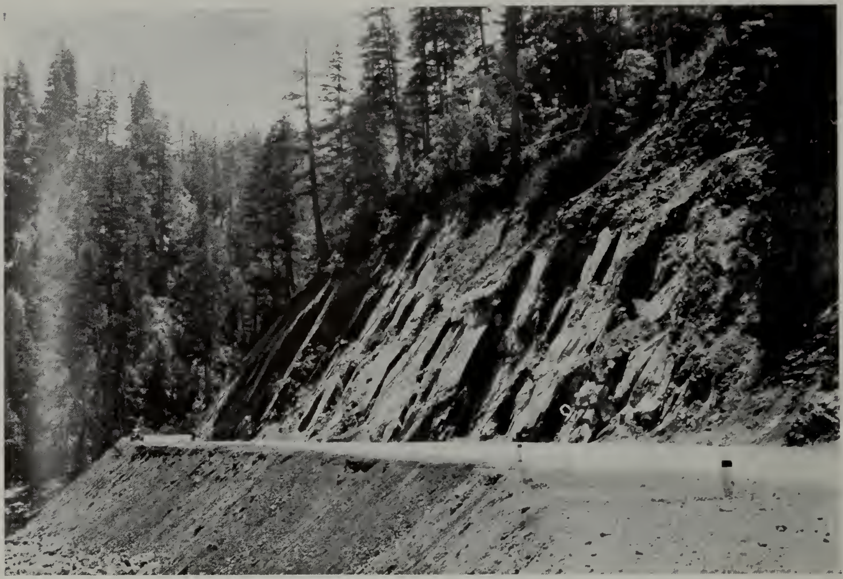

FIG. 5. Galice? slates exposed by Redwood Highway cut on Smith River.

Dothan formation

The Dothan formation also named by Diller [15] from occurrence in Oregon has been traced by Butler and Mitchell [16] southwesterly to the California line. Two sandstones are prominent, one a bluish rock on fresh fracture which weathers to a gray, the other a brown sandstone containing black shale pebbles. Shales and cherts are less abundant rock types. Some basalt and rhyolite flows are interbedded. The formation as a whole is less metamorphosed than the Galice to which it roughly corresponds in age. While in some respects lithologically similar to the Franciscan formation with which it has been correlated,[17] considerations of proximity and continuity favor use of the local name.

Serpentine

With this rock type are included the widespread ultrabasic intrusives, saxonites and dunites, as well as moderately transformed meta-peridotites. Practically none is absolutely unaltered by hydrothermal metamorphism. The group has great areal extent in the Klamath Mountains where its age relationship is less clear than in the Coast Ranges. The large batholiths of Del Norte County intrude the Galice and Dothan formations (late Jurassic) and the Preston diorite. They are intruded by the Siskiyou granodiorite, a correlative of the Sierra Nevadan granodiorite, and are therefore considered late Jurassic.

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[15] Diller, J. S., *op. cit.*, p. 402.

[16] Butler, G. M., and Mitchell, G. J., Preliminary survey of the geology and mineral resources of Curry County, Oregon: Oregon Bureau of Mines, Min. Res. Ore., vol. 2, p. 2, 1916.

[17] Louderback, G. D., The Mesozoic of southwestern Oregon: Jour. Geology, vol. 13, pp. 514–555, 1905.

Hershey, O. H., Del Norte County geology: Min. and Sci. Press, vol. 102, p. 468, 1911.

Many of the economic deposits, particularly chromite and copper, are associated with serpentine or meta-peridotite.

Siskiyou granodiorite

The granodiorite is a coarse-grained plutonic rock containing green hornblende, biotite, sodic plagioclase, orthoclase, and quartz. Apatite and magnetite occur as accessory minerals. Facies with quartz low in amount or absent are monzonites. With orthoclase also low in amount the principal rock type grades into a diorite. This type is of widespread occurrence. Augite characterizes a related group of rocks, the augite diorites, outcropping principally in the Klamath oldland province. Complementary dikes of hornblende-biotite granite cut the batholith. A similar petrologic group from southwestern Oregon has been described by Winchell.[18]

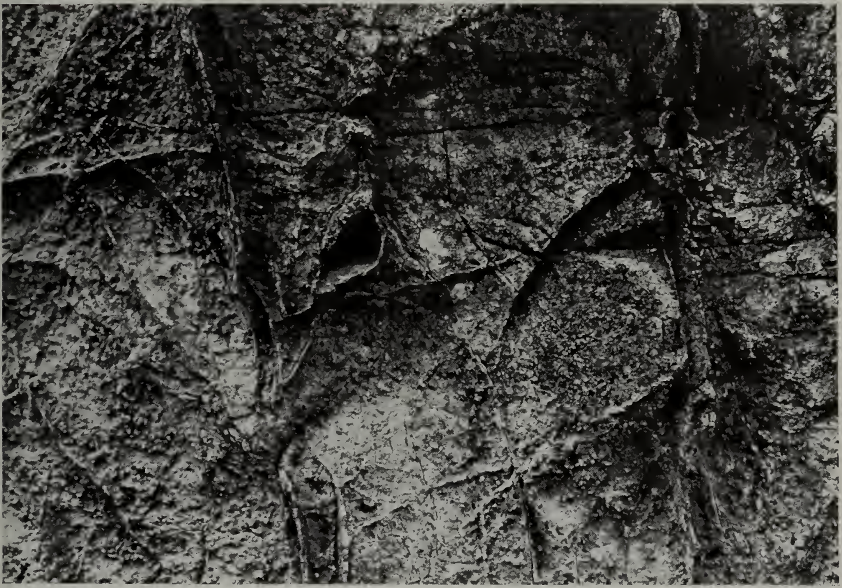

FIG. 6. Surface aspect of weathered metaperidotite, quartz veinlets and chlorite crystals in relief.

This group of rocks is correlated with the granodiorites of the Sierra Nevadan batholith of late Jurassic age. The Siskiyou granodiorite was observed to intrude the Preston diorite (Fig. 4) and ser-

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[18] Winchell, A. N., Petrology and mineral resources of Jackson and Josephine counties, Oregon: Oregon Bureau of Mines, Min. Res. Ore., vol. 1, no. 5, pp. 45–46, 1914.

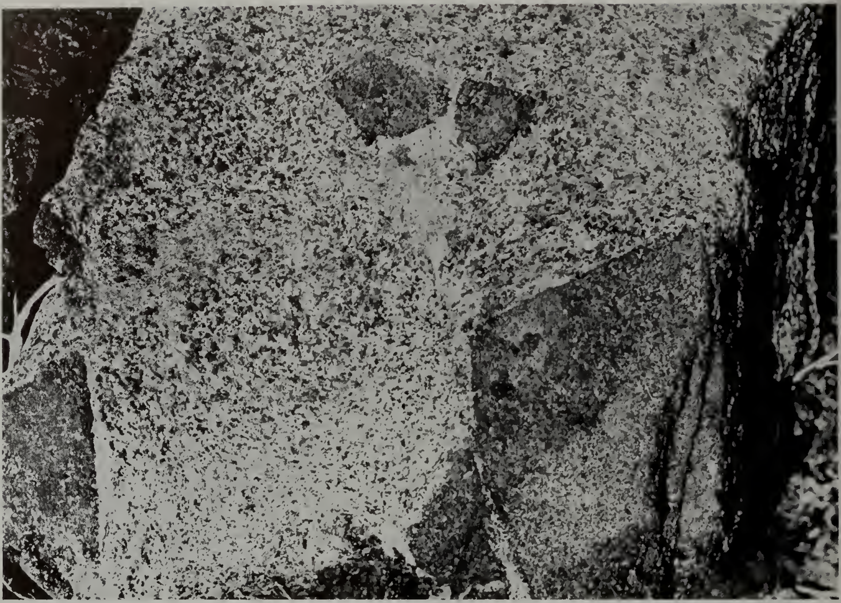

Fig. 7. Siskiyou granodiorite with xenoliths of peridotite.

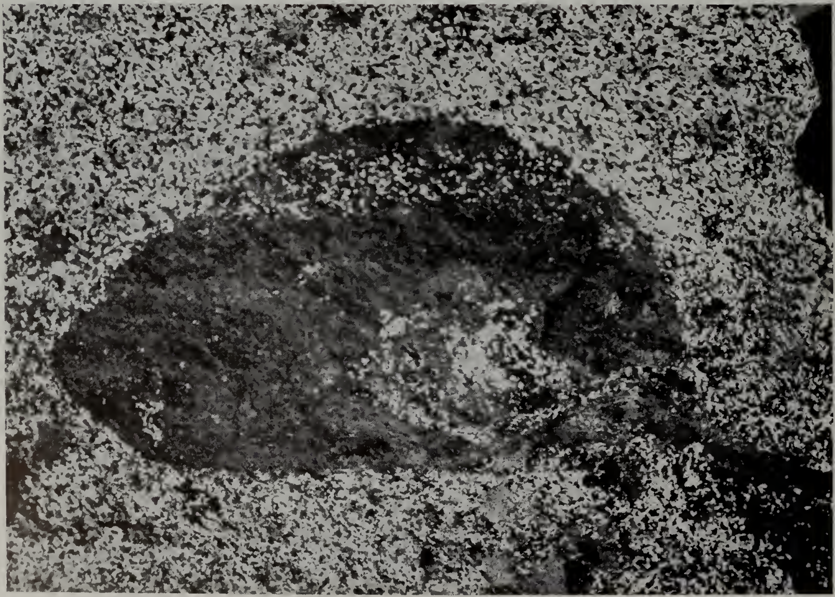

Fig. 8. Siskiyou granodiorite with autolith of hornblendite.

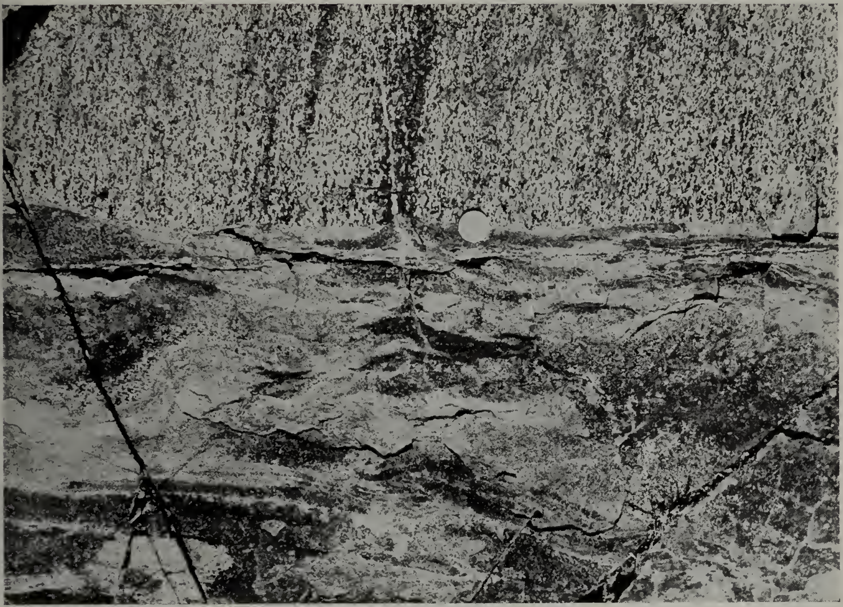

FIG. 9. Siskiyou granodiorite showing flow banding of hornblende crystals cut by lamprophyric dike with flow structure.

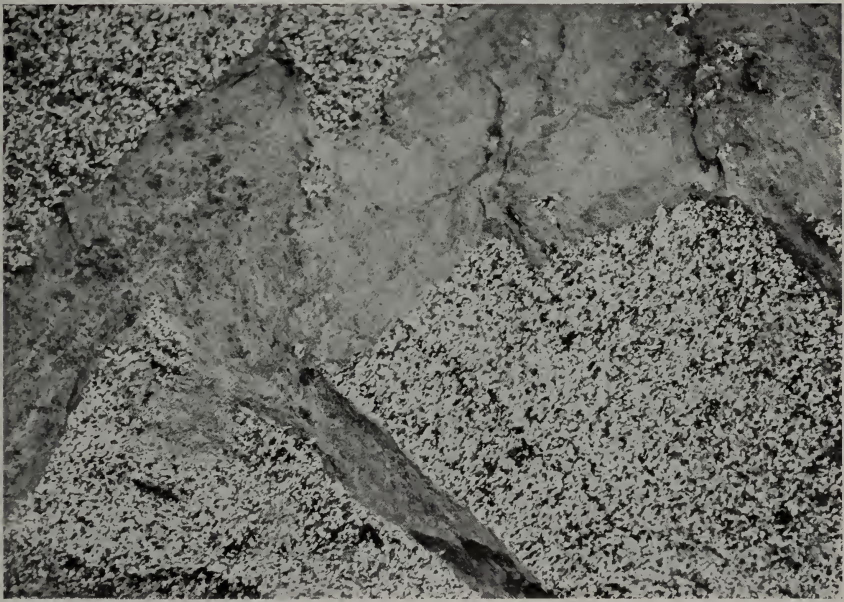

FIG. 10. Siskiyou granodiorite cut by lamprophyric dike.

pentine, but to be intruded by the Patrick greenstone of supposed Cretaceous age.

It is believed that the magma from which this rock was formed introduced the gold of the region and some of the copper.

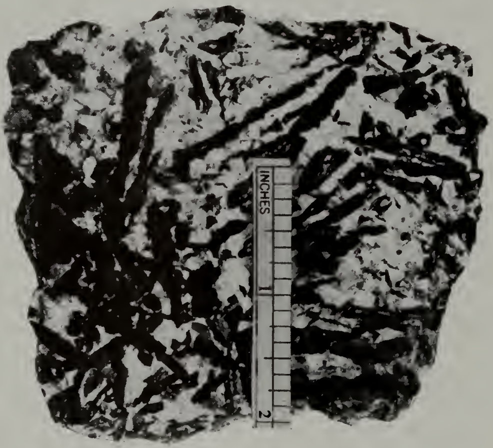

FIG. 11. A pegmatitic facies of Siskiyou granodiorite showing development of large hornblende crystals.

Cretaceous (?)

Patrick greenstone

Greenstone is sometimes loosely used by miners and prospectors for fine-grained greenish rocks commonly containing green hornblende, pyroxene, or chlorite. The rocks included under this category in the present paper are fine-grained intrusive diorites and andesites containing green hornblende and sodic plagioclase with smaller amounts of sericite and pyrite. With quartz present they grade into quartz diorites and dacites, being occasionally porphyritic. The rock exists in various stages of hydrothermal alteration.

In Oregon, Butler and Mitchell [19] observed greenstone cutting lower beds of the Myrtle, a Cretaceous formation. In southwestern Oregon the greenstone is not known to invade the Arago formation (Eocene) and is, therefore, believed to be of Cretaceous age.

Miocene

Wimer formation (Wymer formation of Diller)

The Wimer formation consists predominantly of shales containing kaolin and diatoms with interbedded sandstones and fine conglomerates having a maximum thickness of 150 feet. It is flat-lying and exposed on plateau tops east of Crescent City.

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[19] Butler, G. M., and Mitchell, G. J., *op. cit.*, pp. 31–32.

[20] Diller, J. S., Topographic development of the Klamath Mountains: U. S. Geol. Survey Bull. 196, p. 33, 1902.

A flora submitted [20] to F. H. Knowlton was determined as upper Miocene. The marine molluscan fauna contains *Pecten discus* Conrad thus confirming this age determination.

Pliocene (?)

St. George formation

This northeasterly dipping marine formation consists of sandstones and shales carrying an abundant fauna of invertebrates. The total thickness exposed near Point St. George is somewhat under 100 feet but it is presumably considerably thicker. It lies nonconformably on the Dothan formation (Jurassic) and is overlain nonconformably by the Battery formation (Pleistocene).

Dall [21] has correlated the St. George formation with the beds exposed at Cape Blanco, Oregon, and with the Empire formation of Coos Bay. Beds at one time exposed beneath the wharf at Crescent City and probably part of this formation have yielded *Pecten parmeleei* and *Terebratalia hemphilli* known from the Pliocene of Santa Barbara. The fauna, in the absence of a restudy, is tentatively referred to the

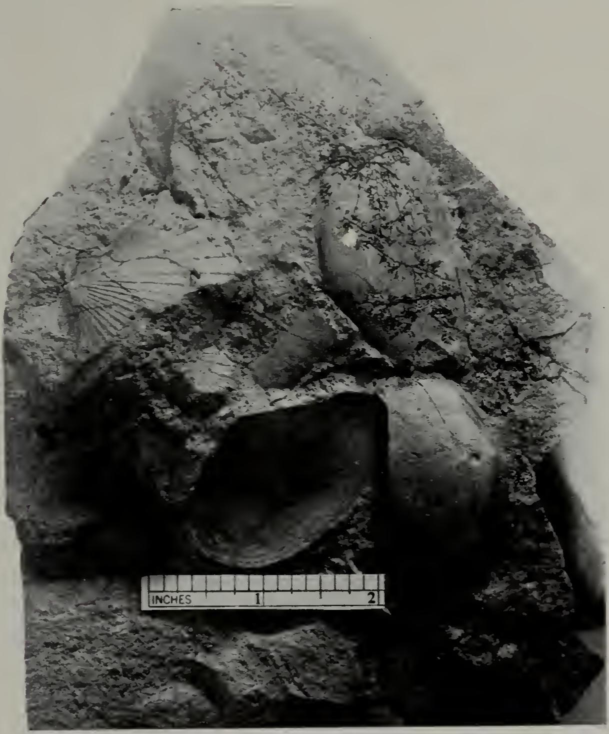

FIG. 12. Wimer shale from Bald Hill showing mollusk imprints.

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[21] Diller, J. S., *op. cit.*, pp. 32–35.

Pliocene.

Klamath oldland gravels

Stream-laid conglomerates existing on remnants of the Klamath oldland to the east of Crescent City have not yielded diagnostic fossils but are rather generally decomposed to a much greater extent than Recent or Pleistocene gravels. For this reason and from physiographic considerations they are believed to be late Pliocene in age.

These stream deposits of a former erosion cycle are commonly auriferous.

Pleistocene

Battery formation

This is a thin marine-terrace capping of unconsolidated sands exposed over the southern portion of the Crescent City platform. A fossiliferous lens contains a small fauna whose general aspect is that of the upper San Pedro stage. On the map, recent beach sands along the shoreline are included with this formation. Much of the surface of the Crescent City platform has been reworked by the wind.

Recent

Alluvium

Stream gravels occur on terraces in valleys of the present drainage system, in the lower reaches of the principal streams, and in the northern portion of the Crescent City platform, near the Smith River.

Structure

The dominant structural axes of this portion of the Klamath Mountains strike in general north and south. Individual batholiths have similar orientation. For the Siskiyou Range as a whole, however, they are distributed in an east-west direction. Rocks of the region are in most cases metamorphosed and have extremely complicated relationships to each other, testifying to a long and eventful geologic life. Intrusive rocks have by their injection separated and obliterated relationships of the meta-sediments.

To the west of the Siskiyou upland the Jurassic sediments are exposed in north-south belts with bevelled outcrops, with Mesozoic intrusives intervening. The region was apparently the seat of intense orogenic activity at the time of the Sierra Nevadan orogeny in the late Jurassic. At this time the sedimentary series were folded, metamorphosed, and intruded. Uplift and truncation led to the present areal distribution exemplified on the Klamath oldland.

Certain formations have on the whole a homoclinal dip, the Grayback (Devonian) striking northeast and dipping southeast, the Galice though locally contorted, striking nearly north-south and dipping east. The Dothan strikes in general northwest and is folded.

Faulting is prominent both on a large and small scale. Contacts with serpentine usually show displacement. Several faults with displacements of 100 feet or less were observed. Three major fault zones were located. To the east, the Orleans fault of Hershey, a steeply-dipping reverse fault, separates the Siskiyou upland with its igneous-metamorphic complex from the lower Klamath oldland to the west with its Jurassic meta-sediments and intrusives. The throw has been several thousand feet.

A second line of faulting, perhaps a continuation of the Redwood Mountain fault of Hershey, strikes northwesterly along the west face of the Bald Hills which have been uplifted 400 feet with respect to the area to the west. This fault may continue northwesterly to join the Del Norte fault. The plane of the Del Norte fault has nowhere been observed but is inferred to block out the Crescent City platform and to lie offshore to the south. Structural evidence is afforded by the northeast-dipping Tertiary rocks of the platform which if projected would abut against the Dothan rocks of the oldland province.

The Siskiyou Range in particular and the Klamath mountains in general have been a positive element in the earth's crust during most of geologic time and especially so since the Jurassic. In all the long uplift, dissection, and intrusion, the region has been a massif receiving crustal assaults from all quarters with resulting fracturing, faulting, and metamorphism of the rocks.

SUMMARY OF MINERAL RESOURCES

An extremely varied group of mineral resources is found in northwesternmost California. The deposits are not as a rule of high grade or large. These facts, added to the inaccessibility of this region and high cost of transportation, are responsible for failure to continuously exploit them.

From time to time mining activity has been stimulated by high prices for metals and a number of deposits were exploited for a short time. The first such instance happened in 1863 when copper ore was discovered at Low Divide. Some shipments were made via Crescent City and the ocean. Sporadic prospecting and development work progressed. In 1918 the great demand for metals for war use led to the maximum expansion of mining activity. The mineral most actively sought was chromite because chromium was needed for hardening steel. Del Norte County was the largest producer in the northwest. Some 7903 tons were shipped and 4345 additional tons were mined but not shipped.

The years 1930, 1931, 1932 have seen a marked revival of gold mining which had been relatively unimportant since the activities of the 1850's and 1870's. The high premium placed upon this metal during periods of economic difficulty naturally leads to redoubled efforts in production. Gold has yielded the largest total revenue of any mineral. Placer gold has come from stream gravels of the present cycle, terrace gravels, Klamath oldland gravels and beach sands. Some gold quartz lodes occur but have been on the whole disappointing.

Although unimportant in the past, some cinnabar deposits are being actively investigated and give promise of future development. Such development will be stimulated not only by a higher market value of quicksilver but also by the fact that it can be distilled on the spot, thus eliminating excessive transportation charges.

The occurrence of a number of other minerals may be noted including platinum, osmiridium and awaruite in the placer sands, manganese minerals, talc, Maoric jade, limestone, etc. Brick clay is found near Crescent City.

The peak production of economic minerals reached during the war did not give Del Norte County a high position among the counties of California. Production declined sharply after the war. During the last few years, as the figures for 1930 illustrate, the crushed rock used in highway construction and the rock quarried for the Crescent City breakwater have increased production values.

COMMERCIAL PRODUCTION[22]

	1917		*1918*		*1930*	
Substance	*Amount*	*Value*	*Amount*	*Value*	*Amount*	*Value*
Chromite	3275 T.	$97,255	7143 T.	$360,485	----	-------
Gold	----	1,373	----	565	----	$279
Platinum	10 oz.	853	1 oz.	97	----	-------
Silver	----	8	----	4	----	1
Stone, misc.	----	2,700	----	8,000	----	175,227
Other minerals	----	2,151	----	2,524	----	523
		$104,340		$371,675		$176,030

Stream Placers

The gravels of the present stream beds and stream terraces have been rather generally worked throughout northwesternmost California. None of the gravels of the present cycle are being worked steadily but here and there prospectors are operating in a small way. It is quite certain that gold exists in most of the stream gravels and along the bedrock but it is, excepting occasional concentrations, thinly distributed. Gold has been derived from quartz veins and stringers and from old gravel accumulations of a former cycle of erosion deposited on the Klamath oldland.

Smith River was worked in the early days but relatively little was obtained from the north and middle forks. The south fork was rich in places, particularly near creek mouths.

Throughout the drainage system there are accumulations of black sand. Heavy oxides of iron and chromium have been furnished abundantly by the areas of basic rocks. Diamonds have been found in black sands of Smith River. Platinum and osmiridium derived from the ultrabasic peridotites and serpentines have been in part recovered with the gold from the black sand. These metals have not been found in place. At Antone Kauss' mine on Craigs Creek pieces of coarse platinum up to $25 have been found. The gold itself is usually coarse. On Myrtle Creek, it is said, as high as $1,100 has been found in one piece. The nickel-iron alloy, awaruite, also occurs in the black sands. The variety, josephinite, is found on Josephine Creek in Josephine County, Oregon, to the north. The metal is probably not of meteoritic origin but is derived from peridotitic rocks.

Placer properties of doubtful production have been located on Smith River (middle fork) near Gasquet but have not been operated since the completion of the Redwood Highway which greatly increased the value of the land. The tributaries of the middle fork have at times produced gold. These include the Siskiyou Fork, Patrick Creek, and Monkey Creek. On Monkey Creek is a considerable acreage of gravel bench which at one time was ground sluiced in part. Further development is possible.

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[22] Cal. State Min. Bureau, Rept. XVII, pp. 502–503, 1920.
Cal. State Min. Bureau, Bull. 105, p. 136, 1931.

The south fork of Smith River and its tributaries have been quite productive and certain locations may be capable of additional development and production. Small bars of Coon Creek and Craigs Creek have yielded small amounts of gold. During the last three years an attempt has been in progress to work bench gravels lying up to 50 feet above Hurdy Gurdy Creek about two miles north of its mouth.

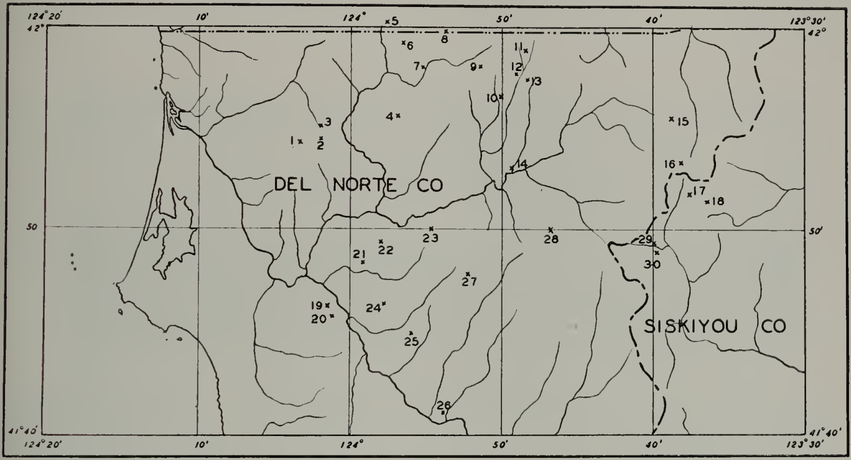

FIG. 13. Index of map of area showing location of mineral deposits.

1. Tyson Rowdy Creek Mine (Chromite).
2. Alta Mine (Copper).
3. Zoar's Chrome.
4. High Plateau Chrome No. 8.
5. Black Beauty Prospect (Manganese).
6. Cleopatra Mine (Copper).
7. Sunny Brook Prospect (Quicksilver).
8. Big Boy Cinnabar Group.
9. Britten Prospect (Copper).
10. Schofield Prospect (Copper).
11. Monumental Mine (Gold lode).
12. Anderson Prospect (Copper).
13. Hard Luck Mine (Gold lode).
14. Monkey Creek Mine (Gold placer).
15. Chicago Camp (Copper).
16. White Feather Prospect (Chromite).
17. The Chromite Prospect.
18. Preston Peak Mine (Copper).
19. Oro Pino Prospect (Gold lode).
20. Ora Anna Mine (Gold lode).
21. Tyson French Hill Mine (Chromite).
22. French Hill Mine (Gold placer).
23. Coon Mountain member of Gordon Mountain Group (Chromite).
24. Coon Mountain Gold Placer.
25. Haines Flat Gold Placer.
26. Big Flat Gold Placer.
27. Gordon Mountain Group (Chromite).
28. Higgins Prospect (Copper).
29. Doe Creek Prospect (Chromite).
30. Bear Mountain Claims.

On Jones Creek for about two miles north of its mouth and on its west side a broad terrace lies about 150 feet above the stream. This is Big Flat and it has an area of several hundred acres. Lower terraces are extensive at elevations of 50 feet and 20 feet above the stream.

Work was started here in 1878 by the Big Flat Gold Mining Company which held some 640 acres of gravel. The property was worked from 1882-1889 and a large gold production was reported. After a shutdown operations were renewed in 1895. The gold obtained was coarse. No large-scale operations have been attempted for many years.

Near the mouth of Rock Creek several claims on small stream terraces have been developed by Bill Hudson. The gold obtained is very coarse.

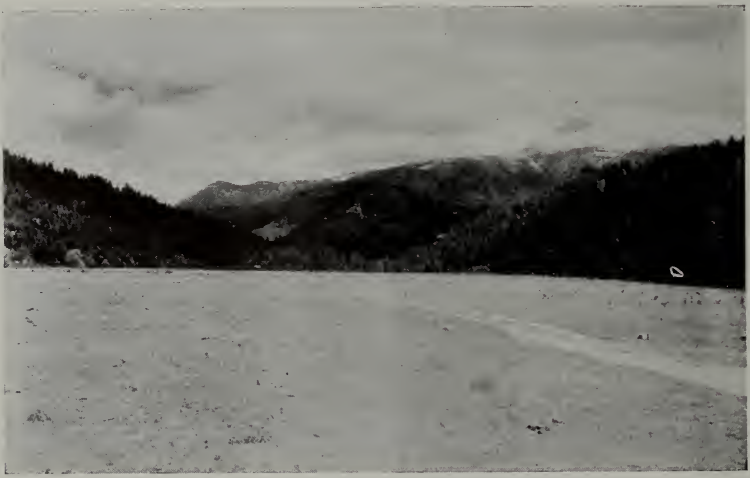

FIG. 14. Big Flat looking northeasterly toward Ship Mountain.

Tributaries to the lower course of Smith River proper have been exploited in the past. On Myrtle Creek in particular a number of placer claims are reported to have been profitable.

Auriferous Gravels of the Oldland Cycle

Gold-bearing gravels occupy valleys of stream courses developed in the former cycle of erosion when the region was worn down to low relief. Patches of these gravels occur on plateaus which have escaped the dissection of the present cycle. Diller's [23] conclusion that auriferous gravels near Waldo, Oregon, were Cretaceous shoreline deposits and Dunn's [24] similar conclusion with respect to deposits on Cottonwood Creek in Siskiyou County, California, have led to statements [25] that the shoreline could be traced through Del Norte County where high-lying gravels occur. The following evidence leads the writer to believe that these gravels are terrestrial. Rounded pebbles are found on many plateau remnants of unequal elevations, i.e. Bald Hills 1900 ft., Childs Hill 2200 ft., Rattlesnake Mountain 3600 ft., Elk Camp Ridge 3300 ft., French Hill 2000 ft., ridge south of Gordon Mountain 2500 ft., Haines Flat 2200 ft., and were apparently deposited by streams on a land surface of this irregularity. On French Hill and Haines Flat the large gravel accumulations occupy shallow valleys and dip definitely in the direction of valley slope. Shingling of the gravels occurs indicating unidirectional current movement. Pockety distribution of the gold has resulted from current irregularities. The gravels themselves are moderately consolidated, uncemented, though deeply weathered, and have a somewhat recent aspect. The Klamath oldland on which the gravels are found was formed during the Pliocene.

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[23] Diller, J. S., Mineral resources of southwestern Oregon: U. S. Geol. Survey, Bull. 546, p. 94, 1914.

[24] Dunn, R. L., Auriferous conglomerate in California: Cal. State Min. Bureau, Rept. XII, 1894.

[25] Haley, C. S., Gold placers of California: Cal. State Min. Bureau, Bull. 92, 1923.

Consequently the gravels are Pliocene, not Cretaceous, and fluviatile, not marine.

French Hill Mine. The French Hill Mine, located on the almost flat summit of French Hill three miles south of Gasquet, is one of the oldest placer properties in the county. Work was started by the Siskiyou Mining Company in 1860. Water was obtained from the headwaters of Craigs Creek. Insufficient water supply proved to be a heavy handicap. The mine is at present owned by the French Hill Mining and Milling Company of which C. P. Terwilliger is president and G. M. Willoughby is secretary.

A newly constructed ditch to Craigs Creek is expected to provide ample water during the winter for operating two or three giants. The gravels lie in a shallow southwest-striking valley on the French Hill remnant of the Klamath oldland. The deposit is about 1¼ mile long, 300 ft. wide, and 30 ft. in thickness. The gravels and cobbles are largely of serpentine and diorite from 4 inches to 12 inches in diameter, averaging 10 inches, while some boulders up to 2 ft. in diameter are present.

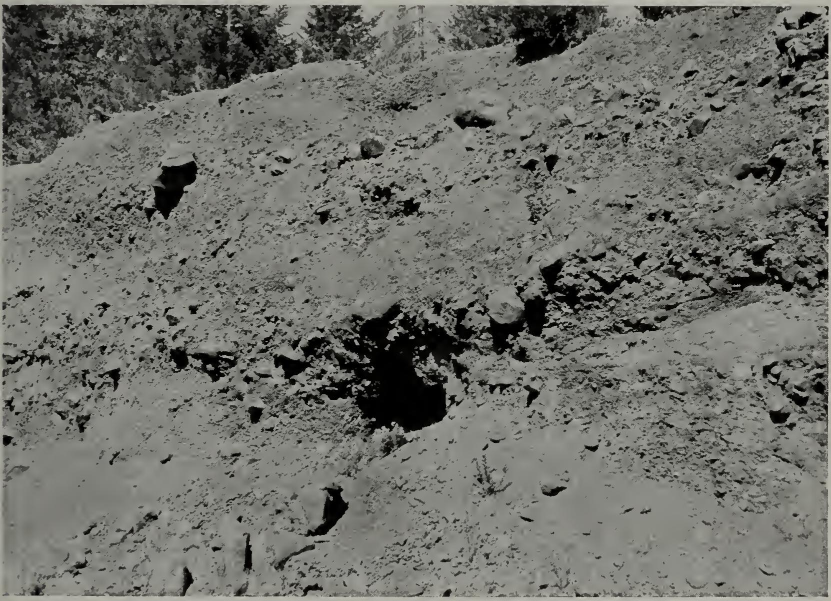

FIG. 15. Gravels of the French Hill Mine.

Metaperidotite and serpentine gravels are usually so thoroughly decomposed that they may be crumbled in the hand. For a few feet above bedrock they are saturated with water and when exposed to the sun they shrivel and break spontaneously.

The black sand is richest along the dacite (greenstone) bedrock and is spotted in a way characteristic of stream deposits. The gold is coarse and is associated with platinum. During former operations the platinum formed 5% of the total values.

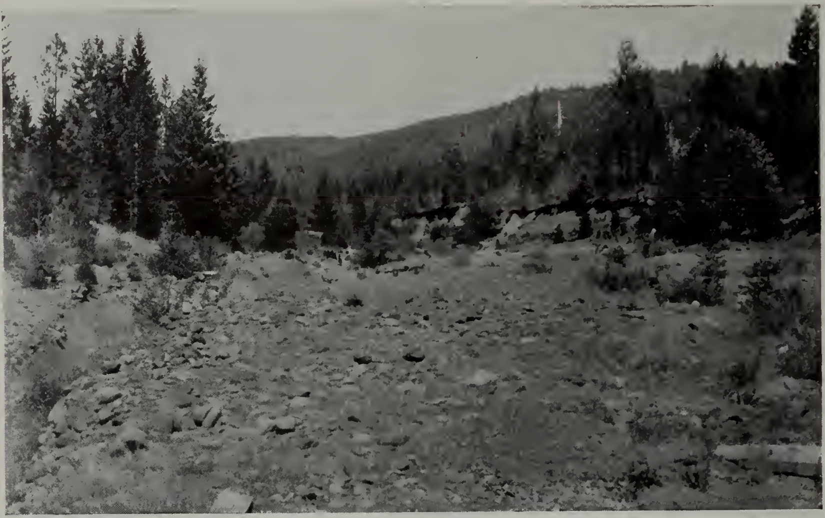

FIG. 16. Looking northerly in the oldland valley of Haines Flat showing former placer workings.

Haines Flat Mine. Work was carried on here in 1877. According to reports mining was never profitable. A large flume and ditch carried water from Gordon Creek to the flat. The Klamath oldland remnant has the gravels preserved in a shallow southward-sloping valley. The deposits are extensive and reach in places 50 ft. in thickness. On the whole they are much finer than those at French Hill.

On the greenstone bedrock is a stratum of fine gravel with some coarse material, then 3 ft. of cobbles, followed by 2 ft. of sandstone which dips about 7 degrees to the southwest. Contrasted with the deposits of French Hill the sorting is good. All the rock types found in the neighboring territory are found in the gravels including metaperidotite, greenstone, diorite, slate, and quartzite. The metaperidotite cobbles have a noteworthy peculiarity: they show a concentric ring of weathered rock about ½ inch in thickness on the outside separated by a thin sheath of quartz from the inside. It is possible that this phenomenon was caused by processes of hydration being continued for a time, followed by mineralization which filled the crevice beneath the expanded shell.

A large cabin was built in the workings with accommodations for a large staff. It is now disintegrating. Several years ago attempts were made to ground sluice some of the gravels, with unsatisfactory results. No information could be gained regarding the character of the gold.

Coon Flat Mine. This property includes an area of gravels on Coon Mountain 5 miles south of Gasquet. They are up to 30 ft. in thickness and occupy a defined channel. Water has been obtained from Coon Creek. The gravels have occasionally been worked by ground sluicing.

Rattlesnake Mountain Mine. A considerable area of gravels on Rattlesnake Mountain, a plateau with an elevation of 3600 ft. about 14 miles south of Gasquet, has been prospected with unsatisfactory gold showings.

Other Oldland Placers. A number of other gravel accumulations of the Klamath oldland remain on certain remnants. Very interesting deposits occur in Josephine County, Oregon, just north of the State boundary of California and south of Waldo. The Osgood or High Gravel Mine has been operated rather regularly over a long period and has produced large amounts of gold. The gravels resemble those at French Hill and rest on a weathered and eroded greenstone basement. They were considered Cretaceous shoreline deposits by J. S. Diller but they appear to the writer to be correlated with the other Pliocene oldland accumulations.

Beach Placers

The beach sands of the Crescent City platform like those of Curry County in Oregon to the north contain large amounts of black sand and considerable values in gold and platinum. A concern known as the Oro Del Norte Company erected a plant two miles south of Crescent City in 1913 and attempted an electromagnetic concentration. The plant was built near the beach and was supplied by a suction pipe and conveyor. The sand was passed to a revolving screen, water was added and the sand and water passed over several plates, the first being large aluminum plates with riffles, the second being small aluminum plates with riffles, and the third a metal plate of unknown composition. An alternating current was passed through the plates and the black sands were supposed to be repelled leaving the gold and platinum. The enterprise failed and no traces of the plant are left.

Small quantities of gold and platinum have been obtained with rockers on Pebble Beach. When the Cresent City breakwater was being constructed it is reported that black sand accumulations in fissures along the bedrock carried fair values.

Gold Lodes

Hard Luck Mine. This property consists of six claims on upper Monkey Creek. Two tunnels were driven on the leached outcrop of a quartz vein. The vein carries arsenopyrite and some gold.

Summit Claim. This is located on the divide between Shelley Creek and Monkey Creek east of Baker Flat (formerly site of Shelley Creek station). Staked by E. A. McPherson and F. A. Sanford.

Monumental Consolidated Quartz Mine. The Monumental Mine was developed by Col. Draper. It consists of eight claims northwest of the old settlement of Monumental on Shelley Creek. They were patented in 1916 and the present owner is the Gunn and Davis Estates. E. A. McPherson of Grants Pass is the local agent. The mine was worked until 1905 and maintained until 1910. Plans are now under way to unwater and resurvey the workings.

The veins are associated with the east-west contacts of Galice(?) slate and greenstone. This contact dips 70° south. A hoist was built over the hanging wall and the shaft passes into the igneous foot wall at a depth of 70 ft. There are a number of levels with drifts at 40 ft., 100 ft., and 120 ft. The ore was stoped out along the drifts, hoisted, transferred to mule carts and hauled one-half mile down the hill to the mill which is located on the old Gasquet stage road. A large camp was located here.

The ore is soft and leached near the surface but passes into a hard arsenopyrite ore with depth. The gold in the quartz vein is associated with specular iron, arsenopyrite, and some copper minerals. The ore is said to average $40 per ton with the high-grade ore varying from $100–120 per ton.

Ora Anna Mine. This mine is one of the older mines of Del Norte County. It consists of one patented and three unpatented claims on the east side of Bald Hill at an elevation of 1400 ft. There are two parallel veins between a slate hanging-wall and a diorite footwall. The veins average 6 ft. in width, striking east-west and dipping 45° north. They are reached by a tunnel 300 ft. long. The ore consists of free gold, arsenopyrite, and other sulphides. The property has been idle since 1897.

Oro Pino Prospect. This property is on the east side of Bald Hill and is owned by T. S. Stevens. An inclined shaft has been sunk 75 ft. on a quartz vein in decomposed pyroxene diorite. The vein strikes north 46° east and dips north 53°. The gold is fine and flaky. It occurs in pockets in the vein. Associated minerals are pyrite and limonite. Small-scale operations have been in progress during the last few years.

Origin of the Gold

The gold belt of the Klamath Mountains lies in a terrane petrographically similar to that of the Sierra Nevada. Quartz veins in the Klamath region have, however, been only slightly productive as compared with those of the Sierra Nevada. They have, in general, been pockety and discontinuous. The intrusive monzonites and granodiorites correlated with those of the Sierra Nevada were probably responsible for the secretion of the gold-bearing solutions. The fine quartz stringers widely distributed in serpentine and older intrusive rocks during the deep denudation of the Klamath region yielded the gold of the placer concentrations.

COPPER DEPOSITS

History

Copper was discovered in the Low Divide District in 1853. Mines were developed in 1860 and shipments of ore were made to Swansea and Germany. This ore brought $41 to $102 per ton. Between 1860 and 1863 some 2000 tons were shipped from the Alta and Union Mines. After 1870 the district deteriorated. During the heyday of mining activity a typical mining camp of several hundred inhabitants existed at Altaville. This site is now known only as Low Divide and there are scarcely any vestiges of the former village. Frank Zoar, an old-time miner, is the only inhabitant.

In the later 19th century there was considerable activity in prospecting numerous other deposits in Del Norte and Siskiyou counties.

Nature and Occurrence

The ores of northwesternmost California are usually rich in chalcopyrite. Pyrite and pyrrhotite are also present. Supergene sulphides are of minor importance as are the oxidized copper minerals. The zones of oxidation and enrichment are relatively shallow. Long continued erosion has been in part responsible. Heavy annual rainfall keeps the water table close to the surface. The ore deposits are frequently found in the serpentine or near the contact of serpentine and diorite. In the Preston Peak quadrangle the diorite concerned is usually the Preston hornblende diorite. The veins themselves antedate serpentinization for in some cases they are extensively brecciated, and fragments of ore are coated with serpentine. The major deposits are related to the Siskiyou granodiorite and its correlatives among the Sierra Nevadan intrusives. In Del Norte County the (Cretaceous) Patrick greenstone (dacite and fine-grained quartz diorite) is responsible for some small deposits.

The pyrite-chalcopyrite deposits of Shasta County, California, which have been large producers, are found in alaskite porphyry, presumably the equivalent of the grandiorite of the Sierra Nevada.

To the northwest in Siskiyou County, California, and Josephine County, Oregon, are a number of deposits which may be grouped in three north-south belts. The easternmost one contains the Blue Ledge Mine near the middle fork of the Applegate River in California and several prospects on Squaw Creek in Oregon. The ore of the Blue Ledge Mine occurs in a vein averaging 5 ft. in width increasing to 40 ft. in places. The country rock is a micaceous schist. The chalcopyrite-pyrite ore is said to average 6% copper and $5 in gold per ton. Some 250,000 tons are reported to be blocked out.

The second belt is represented in the Grey Eagle Mine near Indian Creek five miles north of Happy Camp, California. According to the "Mines Handbook" of 1926 the mine is located on a flat-dipping lode varying from 10 to 80 ft. in width. The underground development is extensive. Reserves of 1,045,000 tons of ore averaging 3.23% copper and 40¢ in gold are reported.

The third belt is of immediate interest to this paper and reaches from Preston Peak north into Oregon. The deposits in California will be described in detail. Those in Oregon near Takilma are especially significant in having been active producers. They have been described by G. F. Kay [26] and by P. J. Shenon.[27]

The Queen of Bronze Mine at Takilma, Oregon, is located on scattered orebodies in serpentine and along contacts with diorite. The nearby Cowboy Mine is similar in the general occurrence. In the Queen of Bronze Mine the largest body removed contained about 10,000 tons. The oxidized zone is less than 90 ft. deep. The primary ore contains chalcopyrite, pyrite, pyrrhotite, quartz, and calcite. The ore averages 8½% copper with $3 in gold and 17¢ in silver to the ton. The ore is transported to Tacoma for smelting. Reduction in copper values led to closing in 1930. The reported total production is about $1,500,000.

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[26] Diller, J. S., and Kay, G. F., Mineral resources of the Grants Pass quadrangle and bordering districts, Oregon: U. S. Geol. Survey, Bull. 380, p. 76, 1909.

[27] Shenon, P. J., A massive sulphide deposit of hydrothermal origin in serpentine: Econ. Geol., vol. 27, pp. 597–613, 1932.

Preston Peak Mine. This property consists of five patented claims on the north slope of Copper Peak and adjacent to Preston Peak. It is reported to be owned by W. T. Thompson and Edgar L. Wallace of Los Angeles. The deposit was one of the pioneer discoveries in the region. It was opened up and considerable underground work was done in 1899 by the Preston Peak Mining Company. Since 1900 no work has been done. Cabins built in Indian Creek Valley have fallen in ruins. The shafts are filled with water.

Mr. K. J. Khoeery of Takilma who had visited the workings gave information regarding the development. The main tunnel was driven southerly in the diorite some 405 ft. At 250 ft. this crosscut an 8-ft. vein of chalcopyrite ore averaging 16% copper and $2 in gold per ton. Here a winze was sunk 40 ft. and at this depth the mineralized zone was 40 ft. in width. A 30-ft. drift driven to the west of this orebody disclosed another vein 12 ft. thick containing the oxidized copper minerals.

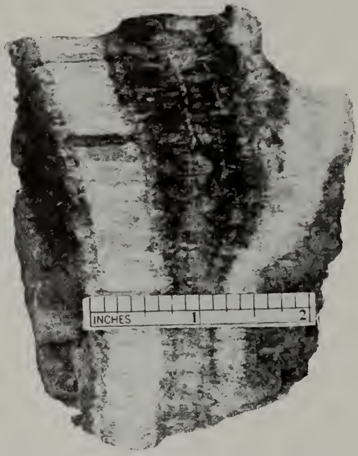

Fig. 17. Asbestos veins in serpentine from Nelson Prospect on Bear Mountain.

A large tonnage is indicated by the exploration. Conditions appear favorable to perseverance of ore with depth. The exploitation of this promising ore deposit will probably not take place in the immediate future because of its isolation. It may be reached only by trail and is in the center of a rugged area.

Bear Mountain Prospects. Several copper prospects are located on Bear Mountain near the Devil's Punchbowl. They were located by Fred Nelson, now deceased, who lived at Trout Camp. *Nelson's Prospect* on the north slope of Bear Mountain is located at the contact of serpentine and Salmon hornblende schist. A tunnel 20 ft. long driven south into the ridge has disclosed no trace of ore. The serpentine is rather generally cut by stringers and veins of asbestos as shown in the accompanying figure. The deposit does not have any commercial interest from this standpoint. The back of the tunnel disclosed some lenticular dikes of altered aplite related to the Siskiyou granodiorite.

Chicago Camp. The Chicago Camp (also known as the *Del Norte Camp*) is located near Whiskey Lake about $\frac{1}{4}$ mile east of Sanger Peak. Some 178 claims were staked by a Chicago association of claim-holders. An extensive program of development was carried on in 1917 and 1918. Five miles of road were built south of Waldo, Oregon, the whole route of about 10 miles surveyed, and the stumps blasted along the route for two miles north of the camp. The proposed grade of the road would not have exceeded 5%. Cabins, laboratories, and power equipment were installed on the site of the deposits. In connection with the claim-holders association a large sanatorium was begun at Waldo, Oregon. At the end of the war with drop in copper and shortage in funds the exploration ceased. A year later all interests were relinquished by the Chicago group. Most of the claims including the office building are now held by K. J. Khoeery. Waldo itself is deserted and largely in ruins.

The copper deposits of the district do not make an impressive surface showing. Several tunnels have been driven on veins in various parts of the property and some low-grade chalcopyrite-pyrite ore has been removed. It is reported that a magnetic survey and diamond drilling revealed a very large orebody at a depth of 300 ft. As in the other deposits of the region serpentine and diorite figure prominently.

Higgins Copper Group. The group consists of five claims on the east slope of Higgins Mountain. They are on the Siskiyou Fork of the Smith River five miles south of its mouth. A few open-cuts have been made on the oxidized outcrops of veins in serpentine.

Anderson Prospect. This is located one-half mile east of Baker Flat (site of old Shelley Creek Stage Station) and one mile northwest of Anderson's Ranch on Shelley Creek. The veins contain some chalcopyrite and pyrite and occur along the contact of the Patrick greenstone and the Galice slates. Four short tunnels have been driven.

Britten Prospect. The Britten Prospect is about a mile and a half north of High Dome on upper Diamond Creek. The ore-bearing veins are in schist and are associated with some diorite. A shaft 60 ft. deep and a drift of 35 ft. disclosed a 9-ft. vein.

Schofield Prospect. This prospect is located on the east side of Patrick Creek about a mile and a half northeast of the old Patrick Creek station. Two tunnels have been driven east into the ridge on veins in the Patrick greenstone. The ore consists of chalcopyrite in quartz.

French Hill Prospect. An open-cut a short distance west of the French Hill Placer Mine has disclosed a deposit of pyrite and chalcopyrite in the Patrick greenstone. Pyrite crystals are commonly found in outcrops of this formation as at Hiouchi Bridge. The Patrick greenstone is believed to be genetically related to the last four occurrences described.

Cleopatra Mine. The copper deposit is located north of Diamond Creek and just south of the Oregon line in Secs. 3 and 4, T. 18 N., R. 2 E. It is one of the older mines of the region having been opened by an English company in the 60's. Ore was then packed by mule to the old McGrew Road. After its abandonment it passed through a succession of hands. More money was invested without return. The seven claims are now held by Paul Dressle of Grants Pass, Oregon.

Several veins from one to two feet in width have been followed by several hundred feet of underground workings. The veins are in serpentine and are apparently associated with dikes and stocks of diorite. The ore observed was of low-quality pyritic type.

Alta Mine. The Alta Mine was one of the earliest developed in Del Norte County. It has been abandoned for many years. A dump is the only marker of the site where formerly between 1860 and 1870 was located a steam hoist, air compressor, mine buildings, shafts, etc. In those days there was an incline 455 ft. deep with four levels and over 1000 ft. of drifts. There was also an adit drift reaching the incline from the gulch. A second vein was opened by a winze below this drift. The Union Mine was located on the northward extension of the Alta vein and had very extensive underground workings. Ore varied from 10% to 18% in copper.

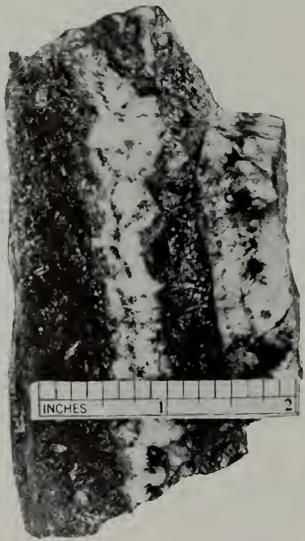

FIG. 18. Chalcopyrite-bearing quartz vein from Schofield Prospect on Patrick Creek.

The mines are located on a vein in serpentine which runs north and south on the ridge east of Copper Creek. It dips east 40° to 60°. The principal minerals of the ore are pyrite, chalcopyrite, bornite, and phyrrhotite. Locally there is some supergene enrichment and chalcocite is present.

Zoar Prospect. To the northwest of his cabin at Low Divide, Frank Zoar has several claims. These lie near the head of Copper Creek on the ridge to the east. Several prospecting tunnels have been driven through the vein. The ore is soft and shows supergene alteration. Chalcopyrite is the principal ore mineral. Samples are reported to run 18% copper.

CHROMITE DEPOSITS

History of Chromite Mining

Chromite was found in the country back of Crescent City before the Civil War. It was brought to the attention of the Tysons in Baltimore who had been mining chromite in Maryland since about 1838. They acquired property on French Hill at Low Divide. From 1869–1873, 1500 tons of ore were shipped annually from Crescent City around Cape Horn to Baltimore. When imported chromite from Greece and Asia Minor reached the United States these Del Norte mines were shut down. There was no further activity until after the World War had begun. Imports from New Caledonia, the principal producer, were practically cut off. After the entrance of the United States into the war the government set about the exploitation of domestic deposits. Large amounts of chromite were mined and shipped. Then the prices broke because of importation of several shiploads of ore from New Caledonia. Chrome mining was demoralized. When the end of the war came a large amount of chromite remained in depots where it may be found today. Operators were partially recompensed for their loss by the government. Since 1918 there has been no activity. Prospects for future activity are not good in view of smallness of deposits, lack of adequate transportation, and cheap sources of supply from Rhodesia and New Caledonia.

Occurrence of the Ore

Chromite deposits investigated by the writer were always found in serpentine or metaperidotite. None was observed in the unaltered rock although such occurrences have been noted.[28] The association with ultrabasic rocks, however, appears universal. Serpentine is widely distributed in the Preston Peak and Crescent City quadrangles and wherever it is present chromite is apt to be found. Chromite prospects are located both in the broad belt of serpentine of the Klamath oldland and in the serpentine stocks of the Siskiyou upland.

The bodies of ore themselves are usually somewhat tabular. They are in reality flat lenses. Although cases of gradational contacts with the country rock are known the lenses studied in Preston Peak and Crescent City quadrangles have sharply-defined boundaries. These surfaces are frequently slickensides.

Nature of the Ore

Minerals

The principal ore mineral is chromite whose formula is $FeO.Cr_2O_3$, representing 68% chromic oxide and 32% ferrous oxide. The iron may be replaced by magnesium and the chromium by aluminum and ferric iron. In this way a gradation may be observed from spinel, $MgO.Al_2O_3$, through picotite, $(MgFe)O.(AlCr)_2O_3$ to the chromite.

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[28] Vogt, Zeit. f. prakt. Geol., Jahrgang 1894, pp. 384–393.

Chromite is coal black in a hand specimen. In thin section it is reddish brown. The streak is brown and hardness is 5.5.

Picotite, the chrome spinel, varies in color from yellowish brown to greenish brown. It has not been identified in Del Norte County ores by the writer. The chrome garnet, uvarovite ($3CaO.(AlCr)_2O_3.3SiO_2$), occurs sparsely along the joint planes of the chromite. The green euhedral crystals of uvarovite are usually very small, rarely exceeding a millimeter in diameter. Another silicate, the chrome chlorite known as kammererite or kotschubeite ($4H_2O.5MgO.(AlCr)_2O_3.3SiO_2$), is occasionally found in cavities and along joints. It is a pink mineral of micaceous habit.

Structure

Even-granular structure. This is the common structure of the chrome ore. The chromite crystals are relatively uniform in size. They rarely exceed two millimeters in diameter in the coarsest ore and in the finer types the chromite individuals may be less than 0.5 mm. in diameter. In the most profitable bodies the ore consists largely of closely-packed hypidiomorphic chromite grains with minor interstitial olivine, pyroxene, or serpentine minerals. In the coarser and lower-grade ores the mineral grains are frequently loose making the material very friable.

Disseminated structure. In this type of ore the chromite grains are euhedral and are scattered in a matrix of serpentine. Portions of the Tyson deposit on French Hill contain octahedra or near-octrahedra of chromite in light-green serpentine, each forming about 50% of the total. The chromite was evidently the first-formed mineral. Chromite crystals are intricately fractured as a result of movements during serpentinization.

Nodular structure. This structure has been noted by Diller in ore from Brush Creek, a tributary to Briggs Creek, Josephine County, Oregon. The nodules according to Diller range from one-tenth to three-fourths of an inch in diameter and may be either spherical or ellipsoidal in form. The lentils are usually parallel in orientation. The nodules of chromite are surrounded by the altered primary silicates (olivine and pyroxene). Veins of serpentine cut the nodules indicating their prior formation. The nodules in ore from the Placer Chrome Mine of El Dorado County, California, are cut by veins of serpentine derived from tremolite which was in turn derived from pyroxene.

Banded structure. Chromite commonly occurs in more or less parallel layers which may vary from 5 or 6 cm. in thickness down to about a millimeter. At first sight the black bands of chromite appear to stand out sharply from the lighter-colored alternate layers. It is seen, however, that the bands are not persistent in many cases. The intervening material may be the original olivine and pyroxene or various minerals derived from them. Serpentine minerals, antigorite, penninite, clinochlorite, and chrysotile, are most common. Magnesite is sometimes present. On close investigation it is seen that the contact is not sharp. Chromite crystals along the margin are interlocked with the serpentine minerals. While chromite is concentrated in the bands, secondary minerals are found in interstices and in the bands of secondary minerals themselves occur scattered chromite crystals. These scattered individuals usually show alignment.

Widely differing theories are held as to the origin of this banding. Vogt [29] illustrates a number of banded chromite ores from Norway and ascribes their formation to the magmatic period. The basis for regarding bands as a flow phenomenon rests in the precedence of chromite in crystallization and its separation before the congealing of the magma. The transecting bands which he mentions are more difficult of explanation and, of course, were formed later. Grout [30] through his studies of the Duluth gabbro rejects many previous ideas of banding of igneous rocks, namely, 1. partial assimilation of inclusions, 2. *lit. par lit* or fluidal gneiss, 3. deformation during solidification, 4. deformation just after solidification, 5. streaked differentiation, with reference to rhythmic cooling or intrusive action, 6. successive intrusions, 7. heterogeneous intrusions. After noting parallelism of banding to boundaries and contacts, he ascribed banding to convection during crystallization.

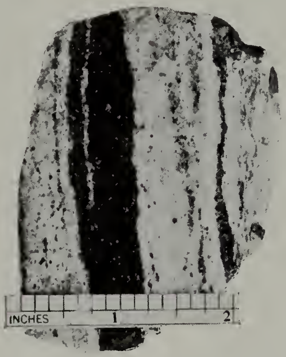

FIG. 19. Banded chromite from the Chromite Prospect on Copper Peak.

Diller [31] in connection with the banded ores of the Hamburg region, Siskiyou County, California, noted parallelism with adjacent gneissic structures and believed the conditions operating to produce the latter also produced the former. Recently Rogers [32] has explained the structure as a replacement phenomenon during a late magmatic stage.

The banded ores of Del Norte County show parallelism to contacts and are believed to have resulted from flowage prior to congealing of the magma.

Origin of the Chromite

Chromite is generally recognized as a product of magmatic segregation. In this respect it is related to magnetite, which also occurs in segregations. Vogt has established the igneous origin of chromite deposits in Norway. Diller regarded the deposits of the Klamath mountains as products of magmatic segregation (crystallization differentiation). All the great chromite deposits of the world are found in serpentine. Those of Asia Minor, New Caledonia, and southern Rhodesia are in this rock. Those of Maryland, North Carolina, California and Oregon are similar though smaller. Occasional association of periodotite, pyroxenite, or dunite indicate the original chemical and mineral composition of the magma from which the chromite was derived.

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[29] Vogt, J. H. L., Zeitschr. prakt. Geol., pp. 381–399, 1894.

[30] Grout, F. F., Internal structures of igneous rocks, their significance and origin; with special reference to the Duluth gabbro: Jour. Geology, vol. 26, pp. 439–458, 1918.

[31] Diller, J. S., Chromite in the Klamath Mountains, California and Oregon: U. S. Geol. Survey, Bull. 725-A, p. 18, 1921.

[32] Rogers, A. F., 30th Ann. Meeting Geological Society of America, Cordilleran Section.

Of late, doubt has been cast on the wholly magmatic origin of chromite. Sampson [33] has suggested the possibility of the serpentinization and introduction of chromite being coincident because of association with hydrothermal minerals. The writer recognizes movement of chromite during the hydrothermal stage. He regards the amounts so transported and deposited as small in comparison with the primary ore. The early crystallization of the chromite of the Klamath deposits has been shown by Diller. In the Castle Crag Mine near Dunsmuir, California, the chromite in places is in direct contact with pyroxenite, dunite, and saxonite. The marginal portions of the chromite are poikolitic with minute serpentine inclusions, the serpentine having been derived from the primary silicates. Thin sections of ores from the Chromite Prospect on Copper Peak north of Preston Peak show penetration of the chromite along fractures by antigorite. Parallel to the contact with the serpentine the chromite crystals are cut by fine, multiple, parallel fractures. The pre-existent chromite lens was thus fractured along its margins by movements during serpentinization resulting from hydration and expansion.

A clear and convincing account of the origin of chromite has been given by Fisher.[34] His conclusions are that there are three periods of chromite deposition which may be stated as follows:

1. Early magmatic chromite, crystallization of chromite well advanced before crystallization of silicates but some overlap.
2. Late magmatic chromite, chromite replaces, surrounds, embays, and cuts cleavable minerals. This exists in largest quantity.
3. Chromite of hydrothermal period, early associated minerals, anthophyllite, actinolite, tremolite, later minerals chlorite talc, kammererite, penninite, magnesite.

Studies of Del Norte County chromite deposits give substantially concordant evidence. Dunite adjacent to chromite lenses in serpentine contains chromite embayed by olivine. Yet some chromite grains in the same thin section exhibiting this phenomenon are interstitial to olivine. Elsewhere chromite has been found concentrated along highly serpentinized fissures in dunite or along contacts between serpentine and chromite lenses. This chromite has probably been dissolved by hydrothermal solutions passing through chromite segregations and chromite-rich silicates and redeposited. Doubt may be expressed whether the late magmatic chromite is as important quantitatively as the early magmatic chromite. It is to be emphasized that chromite of the early magmatic period is very important in developing lenticular accumulations through crystal settling. The Del Norte County chromite deposits are believed to have formed before the congealing of the ultrabasic magma.

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[33] Sampson, E., May chromite crystallize late? Econ. Geology, vol. 24, p. 632, 1929. The comprehensive later paper by this author, Magmatic Chromite Deposits in Southern Africa, Econ. Geol., vol. 27, pp. 113–144 (1932), was not available at the time this study was made.

[34] Fisher, L. W., Origin of chromite deposits: Econ. Geology, vol. 24, p. 691, 1929.

Description of the Deposits

The Chromite Prospect. This prospect is located on the northeast slope of Copper Peak about ½ mile west of Cyclone Cap. It has been held by A. C. Hoofer and George Elder. Some chromite has been mined but none has been shipped.

The deposit is a north-south directed lens in serpentine country rock. The lens is about 40 ft. thick and unknown length and depth. It is probably at least 100 ft. long while a test shaft shows it to be over 20 ft. in depth. In addition to the test shaft there are two tunnels about 20 ft. long.

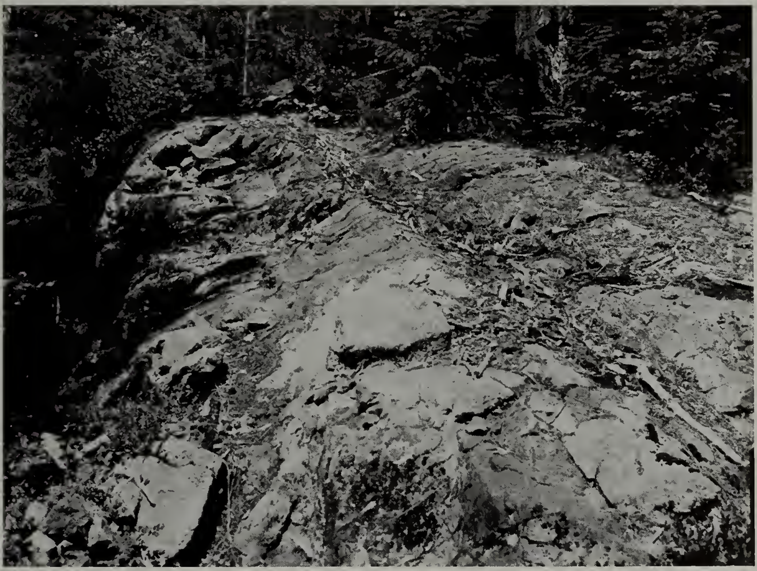


Fig. 20. Glaciated outcrop of chromite lens in valley of Doe Creek. Lighter patches on top are serpentine.

Most of the ore is massive of the even-granular structure although some banded ore exists near the contact. The chromite is frequently veined with chrysotile and in places is coated with serpentine. Brecciation is general.

Doe Creek Prospect. This is northwest-southeast striking lens in serpentine located on Doe Creek at an elevation of 3400 ft. No exploration or development has been done. The prospect is held by Homer White and Jim Hogue. The lens is about 10 ft. thick, 50 ft. long, and of unknown depth. It is shown in Figure 20.

White Feather Prospect. This prospect is located on the ridge east of Young's Peak. It is a lens in metaperidotite which on the surface appears small. No development save a small open-cut has been done. The chromite appears to be high grade. The prospect has been held by A. C. Hoofer and George Elder.

The White Feather and the two previously described prospects are unfavorably situated with respect to transportation. Ore would have to be carried by pack train for about 12 miles. This feature will undoubtedly prevent development for many years.

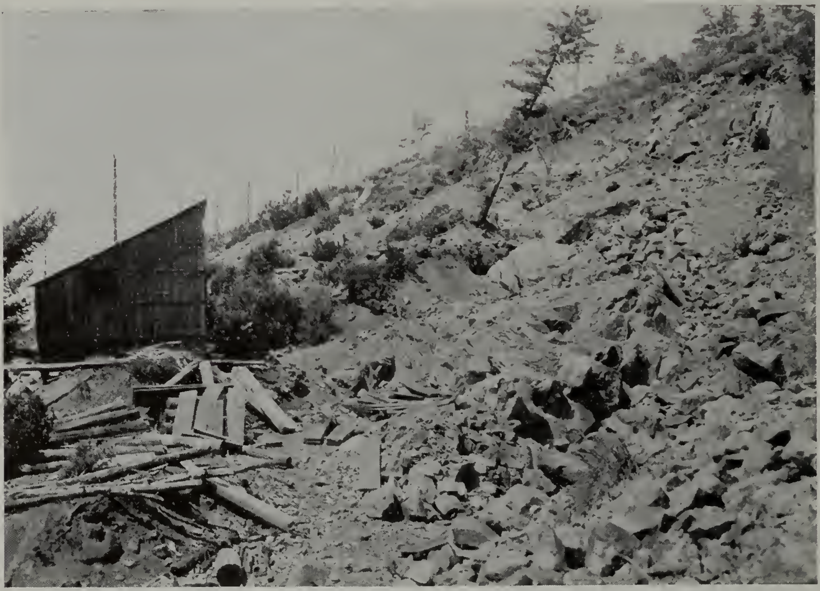


FIG. 21. Workings of High Plateau Chrome No. 8 looking northwesterly along the strike of the lens. Body bounded sharply by joint planes.

Gordon Mountain Group. The group of chromite deposits on and about Gordon Mountain were operated by the California Chrome Company during the World War. Much preliminary labor was required to render them accessible. The road was extended from French Hill some six or seven miles to Gordon Mountain. Since abandoning of the deposits the U. S. Forest Service has extended this road south to Big Flat.

The group consists of five deposits, the Zinc Saddle, No. 7, No. 8, Rowen, and the Madrone. To the southwest of the highest point on Gordon Mountain a short distance is a chromite lens in serpentine. Most of the body appears to be buried and comparatively little worked by open-cut. The shaft is filled with water to within 30 ft. of the surface.

Another chromite lens in serpentine occurs on the slope north of the gap between French Hill and Coon Mountain. This lens strikes northwest-southeast and varies in breadth from 10 ft. on upper slope to 20 ft. lower down. The ore was high grade but relatively small in amount, much of the body having been eroded away. Some of the ore contained admixture of serpentine.

French Hill Mine. This mine was one of the first located on Del Norte chromite. It is owned by the Tyson Mining Company of Baltimore, Md. The mine is located on the southern margin of French Hill at an elevation of 1700 ft.

The ore lens strikes northwest-southeast and plunges south beneath the hill slope. It lies in the serpentine at the contact with micaceous schist on the east. This schist strikes north-south and dips about 30° east. The serpentine is extraordinarily brecciated and contains scattered small pieces of chromite. Much of the ore is of even granular structure but near the northwest part of the deposit a low-grade disseminated ore appears. This ore consists of euhedral chromite individuals in a matrix of serpentine.

The ore was mined from a glory hole about 50 ft. in diameter and removed through two tunnels striking the orebody about 50 ft. below the surface. The ore was transferred to trucks. The wooden bunkers have slid into the road with about 15 tons of ore in them.

High Plateau Chrome No. 8. This deposit was one of the largest producers in 1918 when it was owned by E. J. Hawkins of Crescent City and operated under lease by Adams and Maltby. It lies on the north slope of Low Plateau at an elevation of 2700 ft. in the north half of Sec. 28, T. 18 N., R. 2 E. A narrow-gauge road from 5 to 6 ft. wide was built up Diamond Creek to connect with the Wimer Road. In 1918 the ore was transferred from the bunkers to narrow-gauge Ford trucks which carried it to bunkers at the junction with the Wimer Road. Here it was passed via standard-gauge trucks to Grants Pass. The deposit is now claimed by A. P. Jepson.

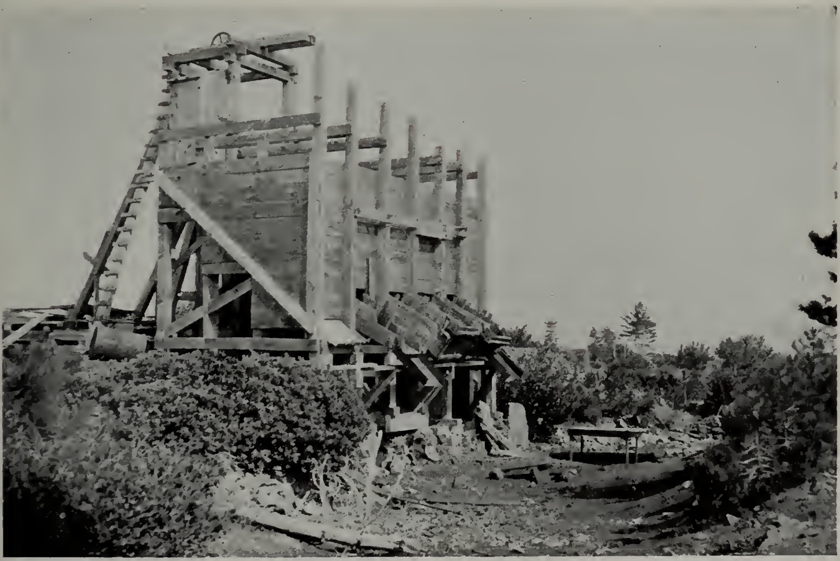


FIG. 22. Hoist and bunkers over ore lens, Tyson Rowdy Creek Mine.

The orebody is arcuate, striking in general northwest. In places the lens is shallow. While many tons have been removed a large quantity remains. The contact with serpentine is not sharp and small nodules of chromite are found in the adjacent country rock. Toward the northwest end a cross-section of the orebody may be seen. The north 1½ ft. is of high-grade ore probably running over 52% chromic oxide. About 20 ft. of low-grade ore is exposed to the south. The chromite in this ore is coarsely crystalline with a matrix of decomposed serpentine minerals. This ore is very friable. Chrome garnet and chrome mica are common.

Rowdy Creek Mine. This mine is owned by the Tyson Mining Company and consists of one claim located on Rowdy Creek (Copper Creek) and three claims on High Divide Mountain about 2 miles southwest of Low Divide itself. High Divide Mountain is flat-topped, an oldland remnant, lying at 2200 ft. elevation.

The orebodies are lenses in serpentine and dunite. The main body was worked through a shaft now filled with water to within 40 ft. of the surface. A hoist and dump fed ore to the bunker whence it was passed to trucks. The ore was transferred at Crescent City to ships. The lenses strike northwesterly. Those to the northwest of the main orebody were mined by open cuts.

Most of the ore is of even-granular structure but some is banded chromite and serpentine.

Zoar's Chrome. This lies 100 ft. southwest of the cabin at Low Divide and is owned by Frank Zoar. The ore occurs in a vein 8–10 inches wide and as nodules in serpentine. About 40 tons of 54% ore were removed during the war.

QUICKSILVER DEPOSITS

History

Cinnabar was discovered on Diamond Creek in the northwest ¼ of Sec. 11, T. 18 N., R. 2 E., in the early 50's. At that time placer miners from as far as Kerby, Oregon, a distance of 35 miles, went there to obtain mercury for amalgamation processes. It is reported by K. J. Khoeery who obtained his information from Bill Wimer that a shaft was sunk on the cinnabar ledge. A fire was built in the shaft and mercury condensed on the walls, which were wetted occasionally to keep them cool. After such crude roasting the quicksilver was collected from the bottom of the shaft. The property was first located by an English company in the 60's. It was claimed by many others thereafter. In 1916 it was claimed by John Taggart and associates of Smith River. They built a retort in 1917 with three units and underdraft. Three-inch pipe condensers ran into water. The retort had a capacity of 500 pounds of ore and was retorted for six hours. One flask of quicksilver was recovered in 1917 when operations ceased. It was found that most of the quicksilver was being lost.

Sunny Brook Prospect. This property is now held by Lee Brown of Los Angeles, who has two center claims, and by John Taggart of Smith River, who has two claims to the south and one to the north. In 1930 some development work was being done. The main shaft which was caved in 1917 was being uncovered.

The ore mineral is cinnabar, HgS, which occurs in stringers in quartz veins with serpentine country rock and in fissures in the serpentine itself. There seem to be two parallel lodes striking due north. These are much fissured. They may be associated with the broad dikes of hornblende diorite outcropping 100 ft. to the northwest. These may have served as the source of the ore as they are also associated with the Big Boy cinnabar deposits.

The workings and retort are on an extensive terrace on the northwest side of Diamond Creek. Above the ledge is an overburden of a few feet of creek boulders. A cut has been made 100 ft. north of the retort which is 40 ft. long in a north-south direction and 10 ft. in width. A crosscut below the creek level is being driven to connect with the old tunnel. In this working bunches of native quicksilver were found along the strike.

Some of the ore seems to be of good grade running from 1% to 2% mercury. The average run is reported to be 10 pounds of mercury to the ton.

Big Boy Cinnabar Group. The Big Boy cinnabar deposits lie on the north fork of Diamond Creek at an elevation of 2150 ft. They are four miles northeast of the Sunny Brook Group. Two claims in Curry County, Oregon, are owned by R. E. Strayner and J. J. Hoogstraat. Three claims in California are owned by O. H. Hagberg, H. W. Lipple, and George Davis. The group is operated under a partnership arrangement.

The cinnabar is not found in the typical vein occurrence but is scattered along fine joint fissures in a huge mass of propylitized diorite.

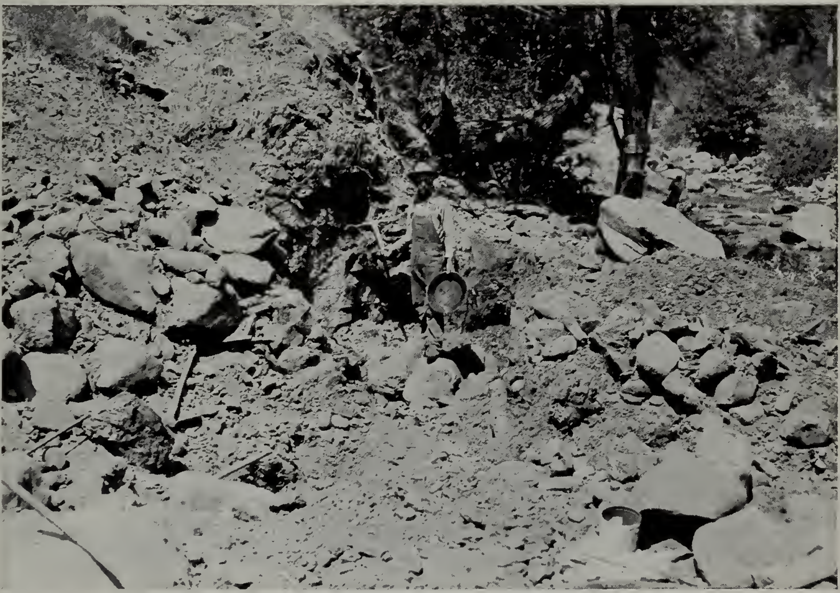


Fig. 23. Sunny Brook cinnabar ledge on Diamond Creek.

In this rock the feldspars have completely altered to kaolinite, and to sercite, and the amphiboles to limonite, etc. The altered diorite is exposed over the top of the ridge west of the camp, and on the west is in contact with or continuous with the dikes passing near the Sunny Brook Prospect. On the north is a tongue of serpentine while to the east less-altered rocks occur including a fresh hornblendite or gabbro containing inclusions of serpentine.

The alteration of the diorite is not believed to be the result of meteoric waters connected with the Klamath oldland stage, although remnants of this surface are found nearby. Rather the cinnabar was introduced and then the rock was altered simultaneously by pneumatolytic action in a late magmatic stage. This view is significant in implying alteration and mineralization to an unknown presumably great depth.

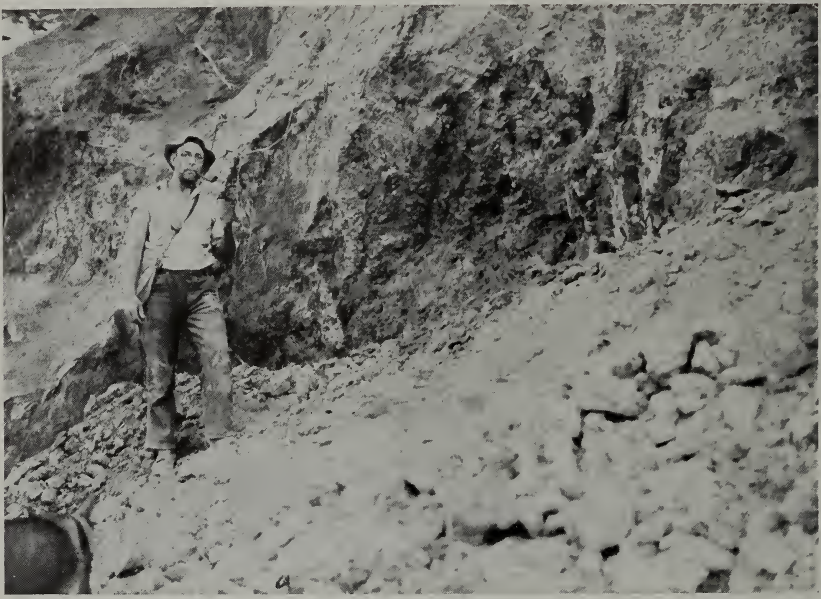
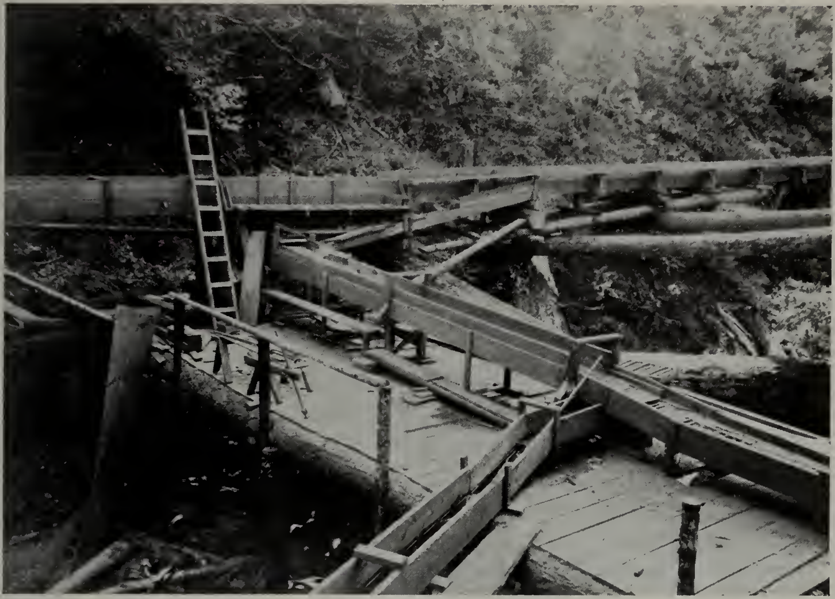


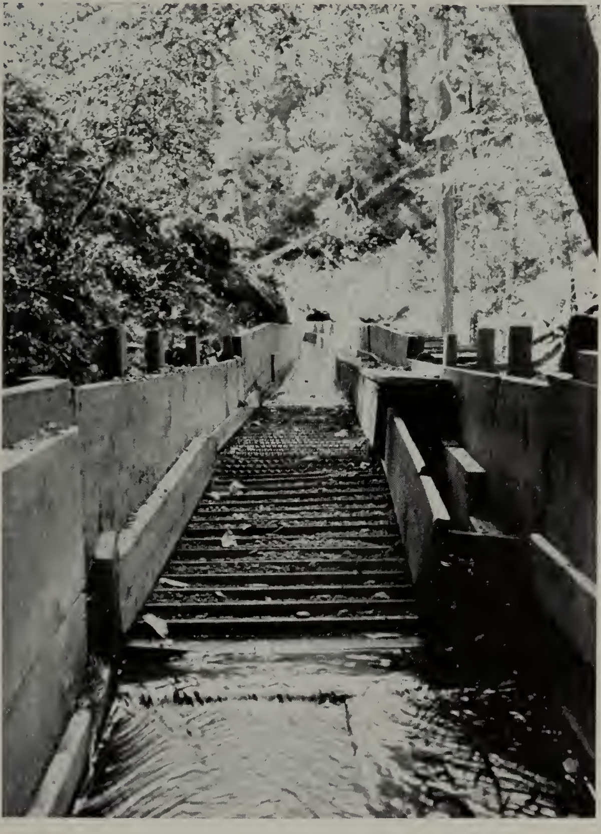
FIG. 24. Propylitized diorite of Big Boy Mine containing cinnabar along joint fissures.

Thus the deposit is very large. A report by W. A. Hutton estimates that it contains 25,000,000 cu. yds. carrying 3–5 pounds of cinnabar to the ton. The difficulties encountered are principally connected with the concentration of this low-grade ore.

The original locator, John Griffin, put in a ditch along the top of the ridge and ground sluiced what was originally a small slide. The water was run through a 10-inch sluice box with Hungarian block riffles. The concentrates were retorted in two 4-inch pipes.

The present equipment, installed by the J. I. L. Dredging Company of Spokane, which leased the property, is essentially a refinement of the above. A 3-inch giant was operated in the slide and the material run through a series of sluices making a gravity separation. It was hoped that in this way the heavier cinnabar crystals could be concentrated. The process was extremely inefficient, however, and the property is at present idle pending installation of more efficient equipment.





FIGS. 25 and 26. Sluice boxes for cinnabar gravity separation.

MANGANESE DEPOSITS

Black Beauty Prospect. This prospect is located on the east side of the north fork of Smith River at an elevation of 1400 ft. It lies in southeastern Curry County, Oregon, about one mile north of the State boundary. It was located in 1918 by John Taggart, James Keaton and Reves Costello and restaked in 1924. Its present ownership is in doubt.

The deposit appears to be a replacement body along a brecciated zone in Dothan cherts and jasper. The surface outcrop on the slope of the hill is 65–70 ft. in width and runs 150 ft. or more in a direction N. 35° W. The ore minerals are pyrolusite and manganite. The oxidized zone extending to the depth of exploration (15 ft.) has considerable wad. The gangue consists of suspended chert fragments and porous silica.

The ore is reported to be of high grade, namely 72% manganese dioxide, but so far as may be seen from the exploration such high-grade ore occurs only in small masses. With depth, however, the chances for high-grade ore appear good.

The development is small and consists of a cut and tunnel extending 30 ft. to the east from the face of the hill. The ore disappears at the back. One short cross-cut extends to the north of the open-cut. Observations indicate that the orebody dips about 60° southwest. A cabin has been built south of the workings.

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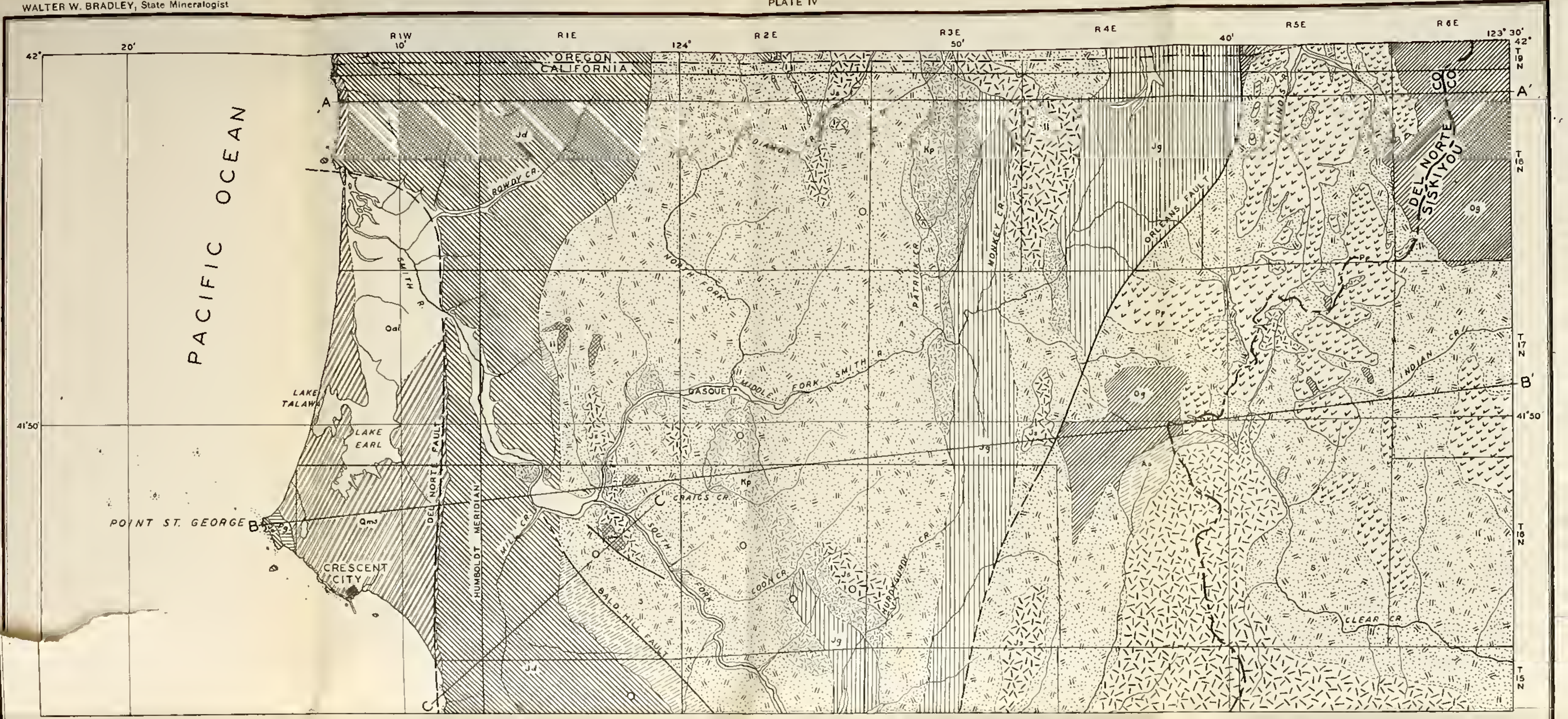

R1W
R1E
R2E
R3E
R4E
R5E
R6E
42°
20'
10'
124°
50'
40'
123° 30'
41°50'
T 19 N
T 18 N
T 17 N
T 16 N
T 15 N
OREGON
CALIFORNIA
DEL NORTE
SISKIYOU
PACIFIC OCEAN
A
A'
B
B'
C
C'
ROWDY CR.
SMITH R.
DIAMOND CR.
NORTH FORK
MIDDLE FORK SMITH R.
GASQUET
PATRICK CR.
MONKEY CR.
ORLEANS FAULT
INDIAN CR.
CLEAR CR.
LAKE TALAWA
LAKE EARL
POINT ST. GEORGE
CRESCENT CITY
DEL NORTE FAULT
HUMBOLDT MERIDIAN
MILL CR.
CRAIGS CR.
SOUTH FORK
BALD HILL FAULT
COON CR.
HURDYGURDY CR.
Qal
Qms
Pg
Jd
Jg
Js
Kp
Dg
As
Pp
S

GENERALIZED GEOLOGICAL MAP OF NORTHWESTERNMOST CALIFORNIA

GEOLOGY
BY J. H. MAXSON
1930

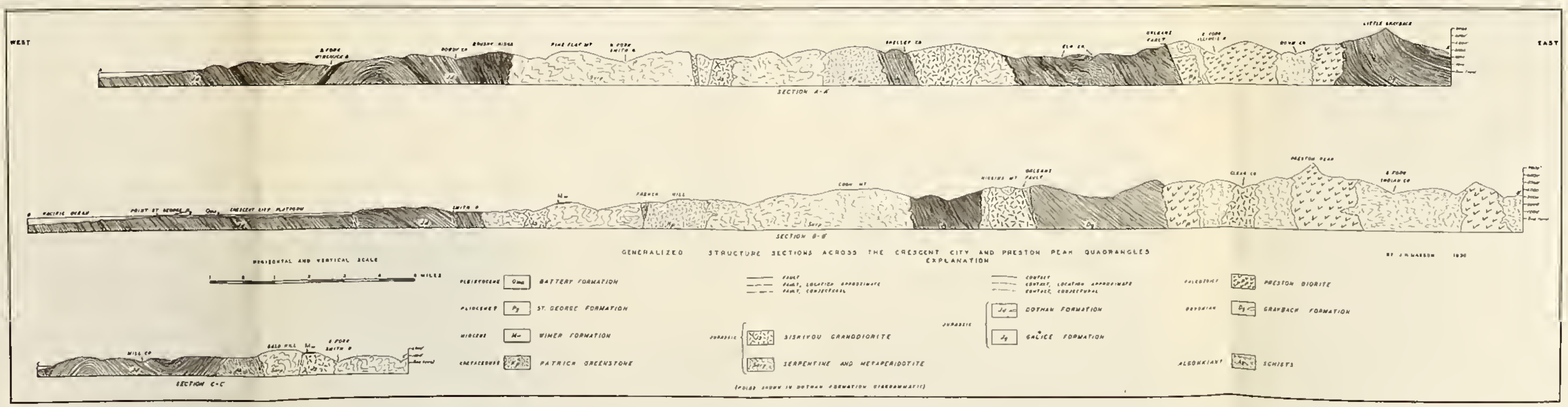
—— CONTACT ---- CONTACT, APPROXIMATE

SCALE
1 0 1 2 3 4 5 MILES

—— FAULT —— FAULT, APPROXIMATE

QUATERNARY	Qal	RECENT ALLUVIAL GRAVELS
	Qms	BATTERY FORMATION AND RECENT
PLIOCENE (?)	Pg	ST. GEORGE FORMATION
MIOCENE	Mw	WIMER FORMATION
CRETACEOUS?	Kp	PATRICK GREENSTONE
JURASSIC	Js	SISKIYOU GRANODIORITE
JURASSIC	S	SERPENTINE - PERIDOTITE
	Jd	DOTHAN FORMATION (FRANCISCAN FORMATION)
	Jg	GALICE FORMATION
PALEOZOIC ?	Pp	PRESTON DIORITE
DEVONIAN	Dg	GRAYBACK FORMATION
ALGONKIAN (?)	As	SCHISTS

O OCCURRENCE OF KLAMATH OLDLAND GRAVELS


WEST
EAST
ROWDY CR
BRUSHY RIDGE
PINE FLAT MT
SHELLEY CR
ELK CR
ORLEANS FAULT
LITTLE GRAYBACK
SECTION A-A'
PACIFIC OCEAN
POINT ST GEORGE
CRESCENT CITY PLATFORM
SMITH R
FRENCH HILL
COON MT
HIGGINS MT
CLEAR CR
PRESTON PEAK
SECTION B-B'
BALD HILL
MILL CR
SECTION C-C

GENERALIZED STRUCTURE SECTIONS ACROSS THE CRESCENT CITY AND PRESTON PEAK QUADRANGLES
EXPLANATION

BY J. H. MAXSON 1930

HORIZONTAL AND VERTICAL SCALE
1 0 1 2 3 4 5 MILES

PLEISTOCENE	Qms	BATTERY FORMATION
PLIOCENE?	Pg	ST. GEORGE FORMATION
MIOCENE	Mw	WIMER FORMATION
CRETACEOUS	Kp	PATRICK GREENSTONE
JURASSIC	Js	SISKIYOU GRANODIORITE
	Serp	SERPENTINE AND METAPERIDOTITE
JURASSIC	Jd	DOTHAN FORMATION
	Jg	GALICE FORMATION
PALEOZOIC	Pp	PRESTON DIORITE
DEVONIAN	Dg	GRAYBACK FORMATION
ALGONKIAN	As	SCHISTS

—— FAULT
—— FAULT, LOCATION APPROXIMATE
—— FAULT, CONJECTURAL

—— CONTACT
—— CONTACT, LOCATION APPROXIMATE
—— CONTACT, CONJECTURAL

(FOLDS SHOWN IN DOTHAN FORMATION DIAGRAMMATIC)

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APPLICATIONS OF GEOLOGY TO CIVIL ENGINEERING

By Douglas Clark *

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INTRODUCTION

The purpose of this article is to show how the geologist can be useful to the civil engineer on various projects of construction, especially during the preliminary work. The importance of the geological investigation can not be overestimated for the reason that the majority of water-well failures, dam failures, reservoir failures, tunnel hazards, slides and rock quarry losses are caused by unfavorable geological conditions.

The usual geological report describes the various formations occurring over the area examined and should be accompanied by a geological map showing the area covered by each formation. The origin, occurrence, character, and composition of the various rocks are discussed. The structure of the formations and the location of any existing faults should be described and shown on the areal map, as well as by geological cross-sections. When foundation sites and design of a structure are considered the earthquake history of the region should be reviewed.

GEOLOGY APPLIED TO WATER-SUPPLY PROBLEMS

One of the most important problems faced by any community, railroad or industrial plant, is that of its water-supply. Usually in valley areas the first water-supply is obtained from wells. Later, as the demands for water increase beyond the capacity of the wells, in which the water-level has been lowered by excessive pumping, or if purer water is desired, a gravity flow is obtained from some stream, providing such a project is feasible. In such a case a dam, as well as a pipe line or aqueduct, is required. A geological report is valuable

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* Consulting geologist, Palo Alto, California.

to the engineer first in the location and drilling of the wells, and later in the selection of the sites for and construction of the dam and pipe line or aqueduct.

Location of Water Wells

In the western states the most important water-bearing strata are the gravels, sands and sandstones of the younger formations. Of these the unconsolidated recent Quaternary alluvial gravels and sands are the largest producers. The sandstones of some of the Tertiary formations, although yielding less water, are nevertheless important as aquifers. The yield of any strata without eventual depletion of the underground reservoir can be no greater than the amount of water absorbed by the formation. The amount of absorption possible depends upon the rate of precipitation, the extent of the drainage basin, the run-off as influenced by the topography, the character of the soil and vegetation, the relative position of the water-bearing strata and the extent of their outcrops.

In addition to the data on precipitation, topography and extent of the drainage basin, the geological report usually describes the extent, thickness, depth, composition, character and relative position of the water-bearing strata, its water-yielding capacity or permeability, the depth to ground-water, the location of any ancient stream channels, the direction of the underground flow of water and the influence on it of structural features—folding, faulting, and unconformities in the formations.

The initial capacity of a well depends upon the thickness and extent of the water-bearing strata and their water-yielding properties. An interesting test of the water-yielding capacity of alluvial deposits was made some years ago in connection with the underground basin in the upper Santa Clara Valley between Coyote and Madrone, Santa Clara County, California.[1] Mechanical analyses of samples of the alluvium showed that the sands form 31% of the alluvium, have a porosity of from 38.9% to 40.8% and when saturated yield from 25.6% to 32.3% of their volume of water. The clays form 69% of the alluvium, have an average porosity of 32% and yield only 3.2% of their volume of water. Theoretically these tests show that the average yield of water equals 12% of the total volume of alluvial sediments in the basin. A careful pumping test conducted by the water company was carried on in this basin over a period of ten weeks during which time the water pumped amounted to 1643 acre-feet. By measuring the lowering water-table it was determined that the volume of alluvial materials drained amounted to 14,955 acre-feet. Therefore, by actual test the water-yielding capacity of the alluvium is 10.9% of its total volume as compared to an estimated yield of 12.0% by laboratory tests.

The quality of well-water depends upon the chemical composition of the formation from which it is produced, the hardness of the water varying with the amount of soluble salts contained in the water-bearing strata. In the Humboldt River Valley, Nevada, the wells derive their water from sediments laid down in the ancient Lake Lahontan of Quaternary age. These beds contain small quantities of soluble salts deposited by the evaporation of the lake-water. These dissolved salts cause the hardness of the well-water, which is classified as poor for use in boilers. The use of this water in locomotives causes the formation of much scale in the boiler tubes which results in costly repairs. In this region the Southern Pacific Company has found it economical to invest heavily in long pipe lines to convey water of good quality from mountain streams to the railroad.

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[1] Clark, W. O., Ground water in Santa Clara Valley, California: U. S. Geol. Survey Water-Supply Paper 519, pp. 30–31, 1924.

The same condition exists in the Great Salt Lake Basin in eastern Nevada and western Utah. Here the well-water is supplied by the sediments of the ancient Lake Bonneville which contain sodium, calcium, magnesium and other salts. On account of the poor quality of the well-water the Southern Pacific Company in 1929 constructed a 15-mile pipe line to convey water from springs in the Pilot Mountains northward to Montello, a division terminal on the railroad.

When the El Paso and Northeastern Railroad (later a part of the El Paso and Southwestern and now a part of the Southern Pacific System) was constructed from El Paso, Texas, to Tucumcari, New Mexico, great difficulty was experienced in obtaining water fit for use in locomotives. On this railroad, between Newman and Pastura which represents a distance of 229 miles, the water-wells extend into gypsiferous rocks of Carboniferous age or more recent sediments derived from these rocks. The water is of very poor quality and contains relatively large amounts of the soluble salts. The use of the well-water in locomotives even after its treatment caused violent foaming, low steam pressure, hard scaling and rapid destruction of boiler tubes. This resulted in demoralized train service until the company expended large sums of money in the construction of pipe lines to bring mountain water to the railroad. The longest of these pipe lines, known as the Bonito River line, has a length of 135 miles and supplies the railroad for a distance of 107 miles.

When wells are drilled into the older formations in order to obtain their water, the structure of the formations is of great importance. Often the largest wells are located in a syncline or structural trough. A geological examination showing the location of such a syncline should determine the most favorable location for wells. The occurrence of artesian wells is due to special structural conditions which include porous strata to carry the water, an impervious bed to confine it and an elevated position of the strata to provide hydrostatic pressure.

The presence of impervious rock directly below the aquifer is of importance because it prevents the downward escape of the water. In the vicinity of Petaluma, Sonoma County, California, the water-supply for most of the ranches is provided by shallow wells drilled into sandstone of the Merced formation of Pliocene age. These sandstones are from 50 to 200 feet thick, and as they are coarse-grained much water is stored in them. The water is held in these sandstones by the underlying impervious rocks of the Franciscan formation.

In some instances faults act as dams on the aquifers in which case the location and dip of the fault is important when considering a well location. An illustration is the Niles-Irvington fault which occurs in the recent valley fills, over a mile from the base of the mountains between the towns of Niles and Irvington in Alameda County, California. Along this fault, buried gravel channels have been blocked by impervious material. The fault acts as a dam preventing the underground water east of the fault from crossing to the region west of it. The result is that the water-table in the wells east of the fault is from 18 to 30 feet higher than in those on the west side.[2]

After a number of wells have been drilled in a district, much valuable information can be obtained if logs have been kept accurately, together with records, kept throughout the year, of the depth to ground water, of the depth to water while pumping at a given capacity, and of the quality of the water obtained. From these records subsurface contour maps may be prepared showing the depth to ground water over the district and the direction of the underground flow. From these data close estimates may be made for depths and capacities of future wells. In the western states many such contour maps of the valley areas have been prepared both by the United States Geological Survey and by the state engineering departments.

Location of Dam Sites

In determining the location of a dam there are four geological factors which are of prime importance, i.e., the depth of the alluvial or other overburden which must be removed; the strength of the foundation rocks to withstand the weight of the dam and the pressure of the water behind the dam; the permeability of the foundation rocks, since the dam must be water tight; and the existence of any faults on which a movement might injure the dam structure.

Before designing a dam the depth of the stream alluvium and other overburden is determined by drilling. The thickness of the alluvial deposit is governed by the topography and the geologic history of the region, especially during the Quaternary period. By considering the geologic record the geologist can often estimate the thickness of the overburden more accurately than can the layman and determine from a preliminary examination whether or not the project is feasible from this standpoint.

At the location of the O'Shaughnessy dam on the Tuolumne River at the lower end of the Hetch Hetchy Valley in Tuolumne County, California, the depth of the stream gravels overlying the granite bedrock was found to be excessive, the maximum depth being 101 feet. Owing to this condition a greater amount of excavation and a higher dam were required than originally planned, which added greatly to the cost of the project.

When considering the strength and permeability of foundation rocks, it is important to determine the origin of the rock, its character and manner of deposition, if stratified, the direction and type of bedding, the extent of fracturing, the occurrence of any soluble material, or of any plastic material, the amount of weathering that has taken place, and the strength of the rock as determined by crushing and microscopic tests. The principal requirements for the bedrock are that it be solid and water tight.

The movement of water in rocks is in the pore space, along bedding planes, and along faults and fractures. Obviously, the amount of leakage or the rate at which the water flows under hydrostatic pressure through the rocks will depend on whether the rock is porous or impervious, whether thin-bedded or massive and on the amount of fracturing in the rock. When the flow of water is along bedding planes or fractures the leakage will be least when the strike of the bedding planes or fractures is parallel to the dam, and greatest when the strike is transverse to the dam providing the dip of the strata is favorable. The direction of the strike of the strata or fractures is one of the most important factors in determining the depth of the cut-off wall and also in determining the amount of cement grouting necessary.

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[2] Clark, W. O., *op. cit.*, p. 61.

At the site of the East Bay Municipal Utility District's Pardee dam on the Mokelumne River, the rocks are schists of the bedrock complex which strike transverse to the river. These rocks are strong, are impervious to water, and, as no faults are present, provide a very satisfactory foundation for the dam.

At the site of the St. Francis dam near Saugus, Los Angeles County, mica schist occurs on the east slope of the canyon and conglomerate of the Sespe formation on the west side. The contact is a fault plane which parallels the canyon on the west slope about 60 feet above its base. On the fault is a seam of clay gouge, and within the fault zone are numerous fractures filled with clay or gypsum. The fractured conglomerate completely disintegrates when immersed. The conclusion of the investigating commissions was that the failure of the dam was caused by the disintegration of the fractured material.

To augment the railroad water-supply in that region the Southern Pacific Company in 1930 constructed a rock fill dam 90 feet high across the Bonito River in the White Mountains, Lincoln County, New Mexico. The rock is an intrusive monzonite, an extremely hard dense crystalline rock, cut on the slopes of the canyon by dikes of dacite porphyry. The monzonite is considerably fractured, the trend of the fractures and dikes being perpendicular to the line of the dam. In order to insure against leakage along the fractures a concrete cut-off wall extending to a maximum depth of 30 feet was constructed across the floor of the canyon. Holes were drilled to a depth of 58 feet below this wall and grouted with cement to a refusal at a pressure of 100 pounds per square inch. From the preliminary examination of the site until the completion of the project there was close cooperation between the engineering and the geological departments of the company.

During the construction of the Lafayette earth-fill dam in Contra Costa County, by the East Bay Municipal Utility District, difficulty was encountered on account of the occurrence of plastic clay beneath the dam. The strata occurring at the dam site include beds of clays and sands of the Orinda formation, dipping at high angles and overlain by alluvial fill from 71 to 91 feet thick, the bedrock in part being sandy clay. When the dam was completed to within 20 feet of its final height the crest of the dam sank vertically 24 feet, causing a movement of the downstream face. The clay below the dam readily absorbed water and became a soft mud which moved out under the weight of the dam. This condition made it necessary to complete the dam with a height of 40 feet less than that originally intended and with greatly flattened slopes.

The location of any major faults in the vicinity of a dam is of great importance. To locate these faults sometimes calls for a regional examination of the geology. Often the course of a stream is on a fault along which there is a zone of rock weakness. In this case the fault is usually covered by stream gravel and in certain instances may not be apparent when the geological examination is confined to the site of the dam but is discovered by a reconnaissance of the region.

Should a concrete dam be located on a fault, slight displacement on the fault might cause damage to the structure and possibly failure of the dam. If the structure is located close to a major fault the more favorable condition is that the fault trace be parallel to the line of the dam rather than transverse to it.

Failure due to fault displacement is less likely to occur to an earth or rock-fill dam than to a concrete dam, as an earth-fill dam is usually of sufficient size to take up the movement of the foundation rock. The maximum earthquake displacement recorded in California occurred along the Lone Pine fault in Owens Valley during 1872. During this disturbance the maximum vertical displacement was 25 feet and the horizontal displacement 10 feet. During the earthquake of 1906 the displacement along the San Andreas fault was horizontal, the maximum amount being 21 feet. When the height of the dam is not great and its slopes comparatively flat an earth or rock fill dam may be considered a fairly safe structure when built across a fault. However, its construction should only be considered when there is no alternative site. In such cases the type of the dam may be determined by geological conditions.

The Crystal Springs and San Andreas reservoirs in San Mateo County, part of the San Francisco water system, are both located on the San Andreas fault. San Andreas Lake is retained by a high earth dam built across the fault. The fault strikes at right angles across the eastern side of the dam. Crystal Springs Lake is retained by a high concrete dam built parallel to the fault. The displacement causing the earthquake of April 18, 1906, occurred on this fault and produced considerable disturbance at the San Andreas earth-fill dam over a strip 150 feet wide. However, the dam was not seriously injured and there was no loss of head in the reservoir.[3] Probably a concrete dam at this location would have been damaged beyond repair. The concrete dam of Crystal Springs Lake 146 feet high, parallel to the fault and a few hundred feet east of it, was not damaged during this earthquake.

A smaller concrete dam at Searsville Lake, San Mateo County, which lies parallel to the San Andreas fault and one quarter mile from it was also uninjured during the 1906 earthquake.

Location of Reservoir Sites

From a geological standpoint the main consideration in selecting a reservoir site is that the rocks be water-tight. The formation underlying the reservoir should be as nearly impervious and insoluble as possible, free from any faulting along which leakage might develop, and should contain no underground cavities. For example the porous lavas, formations containing layers of gypsum and limestone, in which underground cavities may exist, provide unsuitable reservoir sites.

Some time ago the Federal government constructed the Hondo reservoir near Roswell, New Mexico, in connection with an irrigation project, at a cost of about $500,000. The rocks making up the reservoir area consisted of alternating beds of gypsum and limestone, gypsum being relatively soluble. The structure of the formation is that of a faulted and collapsed anticline, the fault traversing the center of the reservoir. Underground cavities caused by the dissolving out of the gypsum apparently had caused the collapse of the structure. This reservoir proved to be useless for it would retain no water. The expenditure would have been saved had a geological examination been made before going ahead with the project.

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[3] Humphrey, R. L., and Sewell, J. S., The San Francisco earthquake and fire of April 18, 1906: U. S. Geol. Survey Bull. 324, pp. 18, 19, 114, 115, 1907.

About 1910 the Nogal reservoir was constructed near Carrizozo, New Mexico, in connection with the Bonito River water system, previously mentioned, to supply the railroad with mountain water. The reservoir lies near the crest of a ridge in a zone of considerable faulting, into which a number of dikes have been intruded. A large amount of leakage varying with the head to nearly one million gallons per day has always occurred along the faults. The largest leak occurs where the main fault crosses a canyon about one-quarter mile north of the reservoir. An effort was made to stop the leakage by cement grouting but without result. A total of 203 holes was drilled to depths varying from 70 to 138 feet and 150 tons of cement were used in the grouting.

Location of Aqueduct and Pipe Line Routes

A geological examination of an aqueduct or pipe line route should determine the location of faults in the vicinity of the route. The hazards presented along a major fault are the possibility of displacement on the fault in which case the line would probably be severed; the increased intensity of earthquake shock near the fault; and the shattered and weakened condition of the rocks in the fault zone.

The aqueduct or pipe line should not be constructed along a fault zone, for movement on the fault would damage the line over this entire distance and replacement might take considerable time and money. One of the three main conduits of the Spring Valley Water Company, supplying San Francisco in 1906 followed the San Andreas fault for some distance, crossing it many times. This line was ruined during the 1906 earthquake for at least one mile of its length and was wisely abandoned.[4] It is often necessary to cross major faults with water lines. In this case the fault should be crossed at right angles and the line so constructed that replacement can readily be made at this point. Valves should be placed on the line above the fault in order to prevent loss of water and flooding in case of damage.

Precautions should be taken in the construction of water lines in the vicinity of a major fault in view of the increased earthquake disturbance which may take place. In San Francisco during the earthquake of 1906 the failure of the water supply was caused mainly by breaks in the distributing mains within the city. These breaks occurred where pipes passed through soft or made ground. No breaks occurred where cast iron pipe was laid in solid ground or rock.[5]

The shattered and weakened condition of the rocks in a fault zone presents a hazard when the construction of the aqueduct is tunnel work. The maintenance of the tunnel may be difficult on account of the poor standing ability of the shattered rock and on account of possible rock movement. When the line is laid along the base of a steep slope which is a fault scarp, slides may occur. Many of the steep fronts of ranges or plateaus, especially in the desert regions of southern California, Arizona and Nevada, are fault escarpments and present possible hazards.

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[4] Humphrey, R. L., and Sewell, J. S., *op. cit.*

[5] Humphrey, R. L., and Sewell, J. S., *op. cit.*

GEOLOGY APPLIED TO RAILROAD, HIGHWAY, AND BUILDING CONSTRUCTION

A geological report is useful to the railroad, highway, and structural engineer when he is considering the safety of foundation rock for buildings and bridge piers, the rigidity of construction required for earthquake proof structures, the maintenance required for tunnels, the possibility of slides in cuts and their prevention, and the location of quarry sites for the production of rock for concrete aggregate, ballast and riprap.

Foundation Sites for Buildings and Bridge Piers

The foundations for large buildings and bridge piers should rest on solid homogeneous rock. This rock should contain no soluble material nor plastic material on which the overlying rock might slide, and it should not be weakened from folding or faulting. The depth to this rock depends in many instances upon the thickness of the overlying alluvial deposit and the depth to which the bedrock has been affected by weathering. Obviously such a structure should not be located on or close to an earthquake fault.

In the design of the Southern Pacific Railroad bridge between Suisun and Army Points near Martinez, California, much consideration was given to the condition of the rock below the piers and to earthquake hazards[6]. Several eminent geologists were consulted. One fault of large displacement known as the Southampton fault lies parallel to the bridge and two miles west of it. The Martinez fault, the location of which is established by the dislocation of the strata in the vicinity of Martinez, passes beneath the waters of Suisun Bay. The projected line of this fault crosses the north end of the bridge. There is no evidence of any recent movement on this fault, and it was the general opinion of the geologists that any displacement on the fault is unlikely, and that if any did occur it would be of small extent. Special borings were taken at the pier sites to make sure that the piers did not rest on the shattered zone of the Martinez or other fault. All the piers rest on bedrock. The depth of the water at the pier sites is from 30 to 55 feet and the maximum depth to bedrock 143 feet below low water, the average depth being 116 feet. Deposits of gravel, sand, clay, and soft mud overlie the bedrock. The base of each pier is 40 feet by 60 feet. To take care of the shear, bending and vibration in the piers, 30 pounds of reinforcing steel were used per cubic yard of concrete.

A Southern Pacific Railroad bridge over the Pajaro River near Chittenden, California, crosses the San Andreas fault at an acute angle. The bridge spans rested on concrete piers with granite coping. The bridge was badly racked by the movement along the fault during the 1906 earthquake.[7] The movement of the earth tended to pull the piers from under the trusses. This movement was resisted by the anchor bolts, and cracking of the piers resulted. The anchor bolts were twisted and bent; the granite caps moved out of position, and many of them cracked.

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[6] Harding, C. R., Location and design of Southern Pacific Company's Suisun Bay Bridge as affected by consideration of earthquakes: Seismological Society of America, Bull. 19, no. 3, p. 162, 1929.

Design of Structures to Withstand Earthquake Shocks

Much attention has been given to earthquake-resistance by engineers and seismologists, especially since the Santa Barbara earthquake of June 29, 1925. That earthquake-proof structures can be designed and built economically was demonstrated in the Tokyo earthquake of September 1, 1923, which was the most severe shock of recent years. Three buildings especially designed to resist earthquakes by Tachu Naito, a Japanese architect who has specialized in this work, came through the Tokyo disaster undamaged. Geologically, the location of the structure is of much importance. The intensity of the shock will depend upon the proximity to the earthquake fault and upon the character of the foundation rock. If close to the fault the intensity is much greater than if some distance away. The shock intensity is least when the structure is built on solid rock and greatest when located on filled or marshy land. As is now customary when formulating building codes for cities, the proximity to earthquakes faults and the earthquake history of the region should be studied when determining the type and rigidity of construction required.

Naito concluded, after a thorough study of the Tokyo disaster, that when the vibration period of a building coincides with that of an earthquake the building may suffer terribly from the harmonizing effect of the two vibrations.[8] A severe earthquake usually has a vibrational period of from one to one and one-half seconds although periods as large as two or three seconds occurred in Tokyo in 1923. A well-constructed seven or eight story building would have a natural vibration period of from 0.4 to 1.0 second. Therefore, a structure should be built as rigid as possible by the use of diagonal braces in order that its period be small thus preventing its natural vibration from synchronizing with that of the earthquake. Also it is important that the walls and partitions should be securely fastened to the steel frame.

The Santa Barbara earthquake of 1925 provided many examples showing how buildings that were well designed and constructed withstood the shock, while those of poor construction failed. The Southern Pacific Railroad bridge across Dos Pueblos Canyon illustrated the strong resistance to earthquakes of well-built steel structures.[9] This bridge is 660 feet long and 65 feet high at the highest point. A witness during the earthquake describes how the bridge vibrated in an alarming manner and that it looked as though the entire structure would topple over. When the vibration ceased the structure returned to its original position, hardly any damage having resulted. Another example was that of a water tank near the Santa Barbara station which was supported on cast iron columns. It collapsed, while other tanks nearby built with structural latticed columns on concrete piers withstood the shock.

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[7] Humphrey, R. L., and Sewell, J. S., *op. cit.*, p. 20.

[8] Naito, Tachu, Earthquake proof construction: Seismological Society of America, Bull. 17, no. 2, 1927.

[9] Kirkbride, W. H., The earthquake at Santa Barbara, California, June 29, 1925, as it affected the railroad of the Southern Pacific Company: Seismological Society of America, Bull. 17, no. 1, 1927.

L. S. Jacobsen of the Mechanical Engineering Department of Stanford University has constructed a large shaking table with which he has undertaken an intensive study of the vibrational effect of earthquakes and the design of earthquake proof structures. The results of some of his work have been published in the bulletins of the Seismological Society of America, and undoubtedly his further experiments will continue to be of much value.

Tunnel Construction

A geological report is of considerable value when making a location for a railroad, highway or aqueduct tunnel. It is advantageous to drive the tunnel in hard firm rock and to avoid caving, moving, and wet ground. This location can best be determined from the study of a detailed geological map and cross section of the area adjacent to the tunnel site. Soft strata, axes of folds, contacts and fault zones should usually be avoided as far as is practical. By a study of the formations and their structure, the occurrence of unusual quantities of water or gas can generally be foreseen.

In case the area is occupied by sedimentary rocks, alternating beds of sandstone and shale may occur. If the tunnel is driven parallel to the strike of these beds, it should be located as far as possible in the sandstone for the shale may cave or swell and cause high maintenance costs. When the formations are folded, it is sometimes advantageous to keep away from the axis of the fold for the rocks are weakest along this axis. The tunnel should not be driven along a contact for this is often a line of weakness, due to possible alteration of the rocks and unconformities. Fault zones are often zones of weakness due to the shattered and altered condition of the rocks. Also, they should be avoided because of possible rock movement along the fault. Underground water often flows along lines of stratification, contacts, and faults, or accumulates in synclinal folds, and knowledge of these conditions is often the means of considerable saving in the cost of the project.

A preliminary report on the geology of the Claremont Tunnel, a part of the Mokelumne River project of the East Bay Municipal Utility District, Oakland, was made by C. D. Hulin of the University of California. The tunnel traverses gravel, sandstone and shales of the Orinda formation of Pliocene age, lava flows, chiefly andesite, the Claremont cherts of Miocene age, and Chico sandstone of Cretaceous age. Owing to the porous nature of the lavas, to the fact that they were badly fractured, and to the synclinal structure of the formation, it was predicted that a large quantity of water would be encountered in the lavas. This prediction proved correct, and while the tunnel was being driven through the lavas, the water caused considerable trouble, being four feet deep in the tunnel at times. It was also foreseen that the structure of the Orinda formation at one location in the tunnel was favorable for the accumulation of gas which could originate in the Claremont cherts. The gas was encountered and one accident occurred.

Bad ground occurring in the Lafayette tunnel, Contra Costa County, also part of the Mokelumne River project was caused by two conditions as determined by Hulin. For the most of its length the tunnel is near the surface where the rocks are more likely to be fractured than at greater depth. The formations encountered include poorly cemented sandstones, shales, and conglomerates of the San Pablo and Orinda formations. The structure is that of a plunging anticline the axis of which is crossed by the tunnel. On account of the folding, the conglomerates were badly broken and did not stand well, while the sandstones and shales, being more plastic, were less disturbed.

Two of the Southern Pacific Railroad tunnels in the Sacramento Canyon, Nos. 5 and 10, cross faults along which the slow rock movement tends to displace the tunnel. After a study to determine the direction of the movement the difficulty was largely overcome by a system of bracing.

Railroad and Highway Cuts

When considering the feasibility of open highway or railroad cuts, in order to avoid slides it is important to know what degree of slope is safe for different kinds of rock under various conditions. Although slides usually occur in wet weather, they are caused by various geological conditions, and an understanding of the geology of the area under consideration is advantageous to the engineer. It is also well to know something about the character of the rock at depth in order to determine the amount of blasting required in making the excavation.

The factors that usually determine the safe angle of slope include the following: the compressive strength of the rock, the angle and direction of dip when the rocks are stratified, the presence of any greasy material such as clay or shale layers, serpentine, mica schist, etc., jointing and the dip of the joint planes, and the occurrence of underground water. Slides are sometimes induced by earthquakes when conditions favor them.

Slides occurring in homogenous rock with few joint planes are due to an unbalanced pressure caused by the excavation. With a given angle of slope, the depth at which this pressure will be sufficient to cause movement of the formation will vary with the compressive strength of the rocks. If the rocks are stratified the direction and angle of dip is important. When the dip is toward the excavation, slides are likely to occur when the slope of the cut is steeper than the dip. This possibility becomes greater with the presence of clay or shale layers, mica-schist and other materials that become slippery when wet. The rocks overlying the slippery material yield to the force of gravity and move to a lower level. The great slides of Culebra Cut on the Panama Canal were caused by the occurrence of volcanic clays. The dip of joint and fault planes has much the same influence on slides as the dip of the bedding planes. Fault planes often present a slickensided surface on which the overlying rocks frequently slide when given the opportunity. The presence of underground water is usually the direct cause of a slide, as it softens the rocks and causes those with greasy surfaces to become slippery. Slides are sometimes started by the vibrations caused by the passing of trains or heavy trucks, or by earthquakes.

Methods which are sometimes effective in preventing slides include the following: decreasing the angle of slope, draining the water away from the slippery material by ditches and properly located tunnels, benching the cut to confine the slide to a particular elevation, driving piling and building retaining walls to give additional support to the material likely to slide, planting trees and shrubs so that the roots will hold the soil, and oiling the surface of the slope to prevent erosion.

A slide near Crockett, California, at one time threatened the tracks of the Southern Pacific Railroad along the Carquinez Straits. The area of the slide was five acres on a slope of about 19 degrees. The rocks are of Cretaceous age predominantly soft clay shales interbedded with gray sandstones. The slide area is traversed by two systems of faults at right angles to each other. The shales are impervious to water but are extremely slippery when wet. The water entered the shales along the fault planes and thus caused the sliding of the strata. In order to divert the water, which follows the fault planes away from the slide area, two tunnels later connected by a cross-cut were driven on either side of the slide. This work helped considerably in arresting the slide.

Location of Rock Quarries

The main considerations in locating a rock quarry or gravel pit are the quality of the rock, the extent of the deposit, the cost of quarrying and crushing the rock, and the location and accessibility of the deposit.

The properties which distinguish a rock of good quality will vary with the purpose for which it is to be used. They include hardness, toughness, tendency to pack, resistance to weather, absorption, and specific gravity. These properties depend largely on the occurrence and texture of the rock and its mineral composition. For example, some of the fine-grained volcanic rocks, especially andesites and basalts are harder and tougher than the coarser grained crystalline rocks, the granites, but do not have a tendency to pack unless used under heavy traffic. In one case volcanic cinder made an excellent railroad ballast when used under light traffic but when subjected to heavy traffic crushed considerably making a large amount of fines. Quartzite being exceedingly hard is an excellent rock for many purposes but does not pack readily when used for road ballast.

Before opening a quarry and constructing a crushing plant, a sufficient supply of rock of good quality at the quarry site should be assured in order to justify the investment. The extent of the deposit will depend upon its geological occurrence. If the rock is of igneous origin it is important to know whether it occurs as a surface lava flow, a dike, a sill, or a large deep-seated mass. If the deposit is of metamorphic or sedimentary origin, the thickness, extent, and inclination of the strata should be determined. One ballast plant investment of over $100,000 became obsolete in two years, because the formation proved to be an isolated mass.[10] The loss could have been avoided by having a geological study of the situation before making the investment.

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[10] The Geologist in Railway Development: An address by Henry M. Payne, Geologist for the Gulf Mobile and Northern Railroad, before the American Railway Development Association at Duluth, Minn., June 19, 1930.

The cost of quarrying and crushing the rock depends upon the hardness of the rock, and upon the occurrence of joint, fracture, and bedding planes, as well as the size of the working face. A hard rock with many joint, fracture, or bedding planes will break more readily than a massive deposit. For example, the columnar basalts, cherts, slates or thin-bedded limestones are easily broken with a small amount of fines and under certain conditions provide excellent rock for road ballast. When rock is quarried for riprap or for building-stone, a massive deposit is required in order that the rock be broken off in large pieces.

When the geology of the region is known, it is often possible to locate within close proximity to the job a satisfactory rock deposit which would be overlooked without this knowledge. Thus, considerable savings are often made in the length of road or railroad into the deposit and in the cost of transporting the rock.

When rock is produced from a gravel deposit the factors which often determine the amount to be invested in plant equipment include the depth of overburden, the thickness and extent of the gravel, the location of the deposit, the size of the gravel, and the quality of the rock which makes up the gravel.

In the location of deposits of building materials, such as sands, clays, limestones, gypsum, diatomaceous earth, magnesite, and pumice, a knowledge of the geological conditions governing the deposition of these materials is essential. The limestone deposit for the first Portland cement plant in Kansas on the Santa Fe Railroad was located by a geologist. This plant paid for itself within three years.[11]

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[11] Payne, Henry M., address, *op. cit.*

THE LAKES OF CALIFORNIA

By William Morris Davis *

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EXPLANATION OF PLATE V

LOCATION MAP OF CALIFORNIAN LAKES

Name	No. on map	Page
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Almanor Reservoir	24	227
Arrowhead Reservoir	111	229
Barrett Reservoir	128	229
Bear Lake	112	216, 229
Big Lagoon	6	231
Big Lake	50	223
Big Sage Reservoir	14	227
Blue Lake, Lassen County	17	200
Blue Lakes, Lake County	41	199, 223
Bodega Bay	63	233
Boiling Springs Lake	23	219
Bolinas Bay	59	233
Borax Lake	43	219
Bristol Lake	115	194
Britton Reservoir	20	227
Buena Vista Lake	102	224
Bumpus Hell	23	219
Butte (Bidwell) Lake	23	216
Cache Slough	52-A	223
Calaveras Reservoir	66	229
Cascade Lake	30-A	212
Castaic Lake	108	223
Chabot Reservoir	65	229
China Lake	101	193
Clear Lake, Lake County	42	195, 197, 230
Clear Lake, Modoc County	16	200
Clear Lake Reservoir, Modoc County	10	189, 227
Cliff Lake	23	215
Cluster Lakes	23	215
Crystal Spring Lake	58	229
Death Valley	96	193
Deep Spring Valley	98	193
Desolation Lake	87	211
Dollar Lake	114	214
Don Pedro Reservoir	74	229
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Eagle Lake	21	201
Earl Lake	1	231
East Park Reservoir	40	229
Echo Lake	34	213, 229
Eleanor Lake	75	227
Elizabeth Lake	109	197
Elkhorn Slough	90	234
Elsinor Lake	119	194
Emerald Lake	23	215
Emigrant Lake	86	213
Estero Americano	62	233
Exchequer Reservoir	73	229
Fallen Leaf Lake	33	212
False Bay	124	235
Freshwater Lagoon	4	231
Garnet Lake	81	207
Gold Lake	27	207
Goose Lake	12	192
Guadalupe Lake	106	235
Haiwee Reservoirs	95	229
Hat Lake	23	217
Helen Lake	23	215
Henshaw Reservoir	122	230
Hetch Hetchy Reservoir	76	227
Hodge Reservoir	123	229
Honey Lake	26	190, 195
Horseshoe Lake, Shasta County	23	215, 218
Horseshoe Lake, Sutter County	49	222
Huckleberry Lake	85	213
Humboldt Bay	7	232
Independence Lake	28	212
Juniper Lake	23	215, 218
Kern Lake, Kern County	103	224
Kern Lakes, Tulare County	93	201
Kings River Slough	89	223
Klamath River Embayment	3	231
Lindsey Lake	52	223
Loon Lake	32	209

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EXPLANATION OF PLATE V

LOCATION MAP OF CALIFORNIAN LAKES

Name	No. on map	Page
Alkali Lakes	15	188, 192
Almanor Reservoir	24	227
Arrowhead Reservoir	111	229
Barrett Reservoir	128	229
Bear Lake	112	216, 229
Big Lagoon	6	231
Big Lake	50	223
Big Sage Reservoir	14	227
Blue Lake, Lassen County	17	200
Blue Lakes, Lake County	41	199, 223
Bodega Bay	63	233
Boiling Springs Lake	23	219
Bolinas Bay	59	233
Borax Lake	43	219
Bristol Lake	115	194
Britton Reservoir	20	227
Buena Vista Lake	102	224
Bumpus Hell	23	219
Butte (Bidwell) Lake	23	216
Cache Slough	52-A	223
Calaveras Reservoir	66	229
Cascade Lake	30-A	212
Castaic Lake	108	223
Chabot Reservoir	65	229
China Lake	101	193
Clear Lake, Lake County	42	195, 197, 230
Clear Lake, Modoc County	16	200
Clear Lake Reservoir, Modoc County	10	189, 227
Cliff Lake	23	215
Cluster Lakes	23	215
Crystal Spring Lake	58	229
Death Valley	96	193
Deep Spring Valley	98	193
Desolation Lake	87	211
Dollar Lake	114	214
Don Pedro Reservoir	74	229
Donner Lake	29	212
Drakes Estero	60	234
Dry Lake, Inyo County	99	193
Dry Lake, Kern County	110	194
Dry Lake, San Bernardino County	113	214
Eagle Lake	21	201
Earl Lake	1	231
East Park Reservoir	40	229
Echo Lake	34	213, 229
Eleanor Lake	75	227
Elizabeth Lake	109	197
Elkhorn Slough	90	234
Elsinor Lake	119	194
Emerald Lake	23	215
Emigrant Lake	86	213
Estero Americano	62	233
Exchequer Reservoir	73	229
Fallen Leaf Lake	33	212
False Bay	124	235
Freshwater Lagoon	4	231
Garnet Lake	81	207
Gold Lake	27	207
Goose Lake	12	192
Guadalupe Lake	106	235
Haiwee Reservoirs	95	229
Hat Lake	23	217
Helen Lake	23	215
Henshaw Reservoir	122	230
Hetch Hetchy Reservoir	76	227
Hodge Reservoir	123	229
Honey Lake	26	190, 195
Horseshoe Lake, Shasta County	23	215, 218
Horseshoe Lake, Sutter County	49	222
Huckleberry Lake	85	213
Humboldt Bay	7	232
Independence Lake	28	212
Juniper Lake	23	215, 218
Kern Lake, Kern County	103	224
Kern Lakes, Tulare County	93	201
Kings River Slough	89	223
Klamath River Embayment	3	231
Lindsey Lake	52	223
Loon Lake	32	209

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CALIFORNIA STATE DIVISION OF MINES
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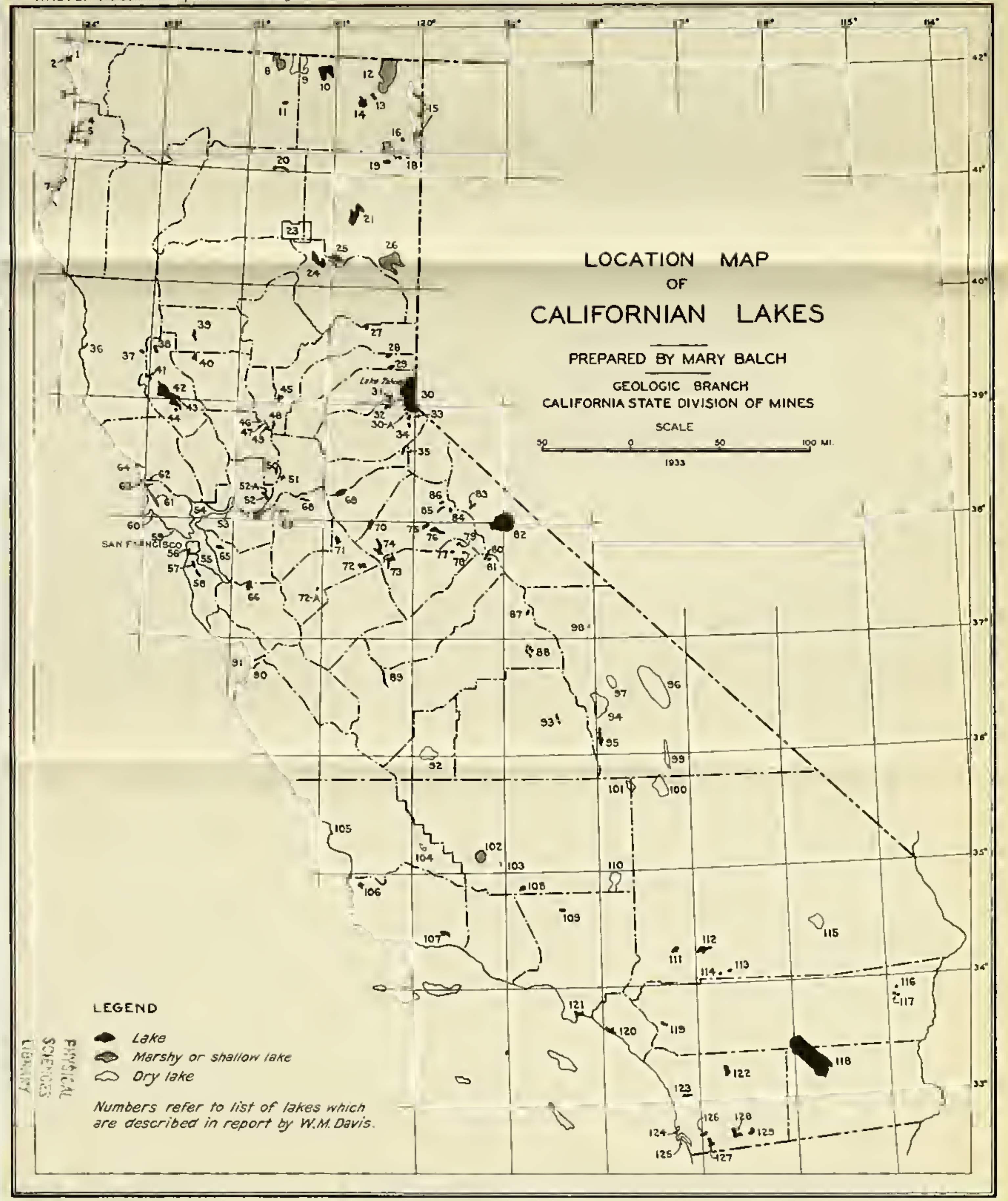
PLATE V

GEOLOGIC BRANCH
OLAF P. JENKINS, Chief Geologist



LOCATION MAP OF CALIFORNIAN LAKES

PREPARED BY MARY BALCH

GEOLOGIC BRANCH
CALIFORNIA STATE DIVISION OF MINES

SCALE
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1933

LEGEND
- ● *Lake*
- ● *Marshy or shallow lake*
- ○ *Dry lake*

Numbers refer to list of lakes which are described in report by W. M. Davis.

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117°
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114°
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PHYSICAL SCIENCES LIBRARY

Name
Alkali Lakes --
Almanor Reser
Arrowhead Res
Barrett Reserv
Bear Lake ----
Big Lagoon ---
Big Lake -----
Big Sage Reser
Blue Lake, Las County -----
Blue Lakes, La County -----
Bodega Bay ---
Boiling Springs
Bolinas Bay ---
Borax Lake ---
Bristol Lake --
Britton Reservo
Buena Vista La
Bumpus Hell --
Butte (Bidwell)
Cache Slough -
Calaveras Rese
Cascade Lake--
Castaic Lake --
Chabot Reservo
China Lake ---
Clear Lake, La County -----
Clear Lake, Mo County -----
Clear Lake Res Modoc County
Cliff Lake -----
Cluster Lakes -
Crystal Spring
Death Valley -
Deep Spring Val
Desolation Lake
Dollar Lake --
Don Pedro Res
Donner Lake --
Drakes Estero -
Dry Lake, Inyo
Dry Lake, Kern

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Lower Klamath Lake	8	189
Lower Otay Reservoir	127	229
McCoy Tanks	117	227
McGriff Lake	46	222
Manzanita Lake	23	202
Mary Lake	47	222
Medicine Lake	11	188, 217
Melones Reservoir	70	227
Merced Lake, San Francisco County	56	234
Merced Lake, Mariposa County	78	212
Mirror Lake	77	201, 214
Mohave Tank	116	227
Mono Lake	82	192
Monterey Bay	91	234
Moreno Reservoir	129	229
Morro Bay	105	235
Mountain Meadow Reservoir	25	227
Murphy Lake	48	222
Newport Harbor	120	235
Noyo River Embayment	36	233
Owens Lake	94	193
Owens Reservoir	72	229
Pardee Reservoir	69	227
Pear Slough	72-A	222
Pilsbury Reservoir	38	229
Pleasant Lake	31	209
Plumas Lake	45	223
Rainbow Lake	23	215
Reflection Lake	23	202
Russian River Embayment	64	233
Saline Valley	97	193
Salton Sea	118	225
San Andreas Reservoir	57	229
San Diego Bay	125	235
San Francisco Bay	55	230
San Pablo Bay	54	230
Santa Barbara Reservoir	107	229
Searles Lake	100	193
Shadow Lake	23	215
Silver Lake	35	209
Snag Lake	23	216
Soda Lake	104	197
Stone Lagoon	5	231
Stone Lake	51	223
Stony Gorge Reservoir	39	229
Suisun Bay	53	230
Swan Lake	23	215
Sweetwater Reservoir	126	229
Sycamore Slough	67	223
Tahoe Lake	30	221
Talawa Lake	2	231
Tenaya Lake	79	214
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Thousand-island Lake	80	207
Thurston Lake	44	218
Tilden Lake	84	213
Tomales Bay	61	233
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Part I. THE ORIGIN OF LAKES

The Forms of the Lands

The forms of the lands are determined in the main by the slow interaction of two antagonistic processes. One process, of interior origin and unsolved explanation, slowly deforms the earth's crust and

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makes its surface uneven. Associated with this deforming process in being of interior origin and of difficult explanation, but apparently acting independently of it, are volcanic eruptions which build up cones and domes and pour out lava flows of smaller or larger extent.

The other process, of exterior origin and simpler explanation, includes all the agencies which tend either to wear down the land surface and reduce the uneven highlands to smooth lowlands or to fill up depressed basins and convert them into smooth plains. Chief among these agencies are weathering and streaming; that is, the ordinary agencies by which rocks are distintegrated, by which valleys are deepened and widened, and by which the irregular slopes of the deformed crust are graded down or graded up to regular slopes and eventually smoothed out as plains. Associated with these familiar agencies are certain more special agencies, such as the glaciers of high mountains and the ice sheets of the Arctic and Antarctic regions; also wind action in deserts, solvent action in limestones, and wave and current action on sea and lake shores.

The fact that many unevennesses, such as mountains and highlands, exist today does not mean that the earth's history is so short that its primitive unevennesses have not yet been worn down, for all unevennesses of ancient origin were worn down ages ago. Existing mountains and highlands are of later upheaval; and although they are vastly more ancient than human history, they are young as the earth measures time; so young that they have not yet been worn down, although the agencies of weathering and streaming have very generally made good progress in carving valleys of continuous descent down their slopes. Hence it may be said in a general way that the highest mountains of today are high because they are geologically young; they represent, although already much dissected by deep-cut valleys, the latest great upheavals that the earth's crust has suffered. It should be understood, however, that geologically young mountains are historically so ancient that they antedate all human records.

The Antagonism of Lakes and Rivers

Inasmuch as rivers carve valleys of continuous down grade from head to mouth, they tend to destroy lakes; for the floor of every lake basin must have an up-grade from its deepest part to the lake outlet. The occurrence of lakes therefore suggests an imperfection or an incompleteness in the down-grading action of rivers, and hence a study of lakes must involve a search for the origin of such imperfection or incompleteness. Such study shows that basin-like depressions, large or small, have been produced in the surface of the lands by irregular deformation of the earth's crust. If the deformation is slow, the resulting basin may be filled with inwashed detritus while the deformation is in progress, and no lake will be formed; but if the deformation is more rapid, the basin will be only in part filled with detritus during its deformation, and a lake will occupy the unfilled part. Where the climate is moist such basins are water-filled to overflowing; where it is dry the basin is only in part water-filled and there is no overflow. In this case the area of the non-overflowing lake comes to be such that evaporation from its surface disposes of the inflow from the entire drainage basin: in the other case the overflow will equal the inflow minus the evaporation from the lake surface.

The study of lakes also shows that some of them occur where the land surface has been unevenly worn down by ancient glaciers, or where it has been unevenly up-built by volcanic eruptions. Moreover, certain desert regions, in the broad basins of which lakes are now small or wanting, are shown by the shore-line terraces still preserved on the basin slopes to have possessed large lakes during a moister and cooler climatic period of the geologically recent past, presumably contemporaneous with the period in which the ancient mountain glaciers and the great ice-sheets of certain continental areas attained their vast extension. All these possible causes of lake production must be investigated.

The study of lakes shows further that, whenever and wherever they are produced, the action of weathering and streaming tends, as above intimated, to destroy them, either by slowly filling their basins with inwashed detritus or by gradually cutting down their outlets and draining off their waters. Thus Lake Geneva, at the northwestern margin of the Swiss Alps, is now somewhat encroached upon by the delta that the inflowing Rhone is building at the lake head; eventually, the delta may replace the entire lake. Likewise, Lake Erie is fated to be drained away in the distant future when Niagara Falls and the rapids upstream from them are worn back sufficiently to lower the lake outlet to the level of its basin floor, which will then be laid bare as a smooth plain.

Lake basins should therefore be considered as resembling, in a smaller way, the greater unevenness of the earth's surface, because they also very generally exhibit the interaction of antagonistic processes: One set of processes producing the lake-holding basin, the other set tending to destroy the basin-holding lake. In other words, the quicker-acting but less enduring processes of lake production are, in time, overcome by the slower acting but longer enduring processes of lake destruction. Lakes are therefore, as a rule, what our old Mother Earth would consider short-lived features of her land surfaces. A few examples of these general principles may be here presented.

Divers Methods of Lake Production

Warped-Valley Lakes

A slight bending or breaking of the earth's crust will affect the slope of river basins and their valleys. If a valley slope is thus increased, its river will run faster and erode its valley deeper; but if a valley slope is decreased even to the point of reversing its direction, a lake may be formed in the depressed part of the valley. A peculiar lake in equatorial Africa illustrates this method of lake-production to perfection. The headwater area of a region drained by the Kafu and Katonga rivers has been slightly down-warped, so that their valleys now slope eastward instead of westward as formerly. The branching Kafu headwaters have thus been transformed, Fig. 1. into the branching Lake Kyoga, 150 miles in length. The Katonga headwaters are more completely submerged in the broad Lake Victoria, of similar measure in diameter. Parts of both rivers now flow backwards into their lakes.

Lake Victoria is the chief source of the Nile, which flows northward from it into Kyoga Lake by one of its branches and out by another. The little eroded Ripon Falls, next north of Lake Victoria, and the extremely narrow gorge below Murchison Falls, northwest of Lake Kyoga, testify to the recency of the time when the lakes were formed and the present course of the Nile was assumed.

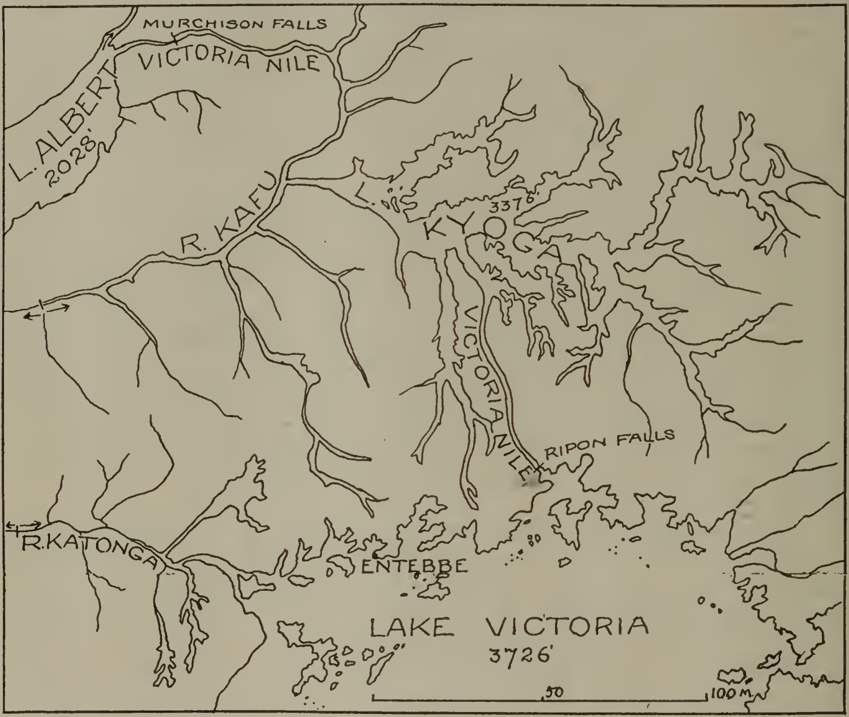

FIG. 1. Lakes Kyoga and Victoria, central Africa; reduced from map in report of E. J. Wayland, director, Uganda Geological Survey.

Fault-Basin Lakes

Certain lakes occupy depressions in the land surface which result from the breaking and tilting of huge blocks of previously nearly level earth-crust, as in Fig. 2. The deep fractures on which such blocks are displaced are known to geologists as faults, and the displaced blocks are called fault-blocks. When some of the blocks are raised to mountainous heights, as in the background of Fig. 2, the depression between them may be called an intermont trough or basin. Some such basins are of so recent a geological date of formation that they have not as yet been much filled by detritus washed down from the adjoining highlands, and rather deep lakes may then occupy a considerable part of their cavities. Central Africa again affords a typical example of this kind in the long and deep Lake Tanganyika; and the exceptionally long and deep Lake Baikal of north-central Asia may be of similar origin.

Other fault basins of more ancient origin are now largely filled with evenly spread layers of inwashed detritus, coarser and steeper-sloping near the base of the enclosing highlands, finer and more nearly level near the basin center. The basins are thus converted into flat, intermont plains, while the uplifted blocks are carved into rugged mountainous forms. Such basins are said to be aggraded, while the mountain blocks are dissected or degraded. Shallow lakes may then occupy the least filled parts of the plains, as in the foreground of Fig. 2.

It must not be imagined that the faulting or flexing of such crustal blocks took place suddenly or that the resulting troughs or basins immediately became filled with great bodies of water. The displacements were probably accomplished by many small movements separated by quiet pauses of years or centuries; and it is to be supposed that a considerable quantity of detritus was washed into the cavities from the enclosing highlands while the displacements were in slow progress. The displacements may have been, in some cases, so slow that the larger rivers of the deformed region held their courses, by cutting deep gorges through the uplifted blocks and filling the depressed areas with detritus. In all cases any lakes that were thus formed occupy merely such parts of the basins as are not otherwise filled. All such lakes may therefore be roughly classified with respect to the proportion that their water volume and area bear to the volume and area of the basin of deformation.

Intermont lakes will overflow if the climate is humid, but not if the climate is arid; for in the latter case evaporation from the lake surface disposes of all the water that the lake receives from rainfall and from inflowing streams and springs. Lakes without outlets are commonly saline, because as told above the minute amount of dissolved saline minerals brought in by their streams accumulates in them. If these lakes lie on the plains of smoothly aggraded intermont depressions, they may be so shallow even during the wetter part of the year that they evaporate in the drier part, leaving a smooth plain of silt in their place. Plains of this kind are called playas and the thin water sheets that temporarily cover them are known as playa lakes.

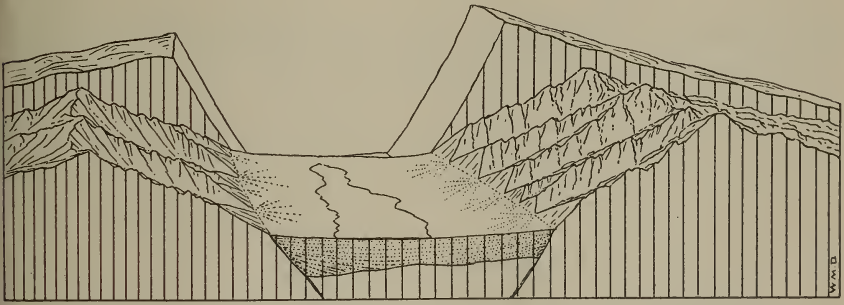

FIG. 2. Background: a depressed fault block between two upheaved fault blocks; foreground, the same, after a considerable period of erosion and deposition.

Nevada, Arizona and southern California, of arid climate, possess a good number of intermont depressions of earlier or later origin, the depth of which has been more or less diminished by deposits of inwashed detritus. Hence, besides some good-sized and rather deep lakes in the younger and less filled depressions of western Nevada, the flat, aggraded floors of many other depressions of the two states contain only dry lake beds or playas, mostly of moderate or small area. These are flooded, if at all, only after winter rains or summer downpours, and even then only by very shallow water sheets. But many of these heavily aggraded basins held much larger perennial lakes during the cooler and moister Glacial Period of modern geological times.

Landslide lakes

It sometimes happens that a steep-sided, stream-eroded canyon is blocked by a landslide, upstream from which a lake then rises, as in Fig. 3. A famous example of this kind occurred in a deep and steep-sided valley of the Ganges headwaters in the Himalaya Mountains of India in September, 1893. The slide descended some 4000 feet, leaving a great bare scar at its source, and forming a barrier in the valley two miles long and from 800 to 900 feet high. A lake gradually rose behind it and gained a length of over three miles. Then overflowing some eight months later, the outrushing flood rapidly cut a gash a mile long and nearly 400 feet deep through the barrier. The lake fell 25 feet in the first hour after its overflow began and 300 feet in the second hour. The resulting flood rose 160 feet 20 miles down the valley and from 50 to 60 feet 70 miles down. Yet such were the precautions taken and so well was the coming of the flood announced by telegraph to the villages down the valley that, although all houses and bridges were swept away, live stock was driven up the valley sides to safety and only one human life was lost, that of a religious devotee who insisted on living at the base of the slide. He was never found after the overflow took place.[1]

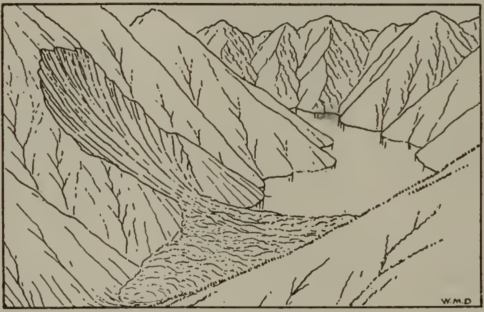

FIG. 3. Diagram of a landslide lake in a mountain valley.

If the obstruction produced by a landslide does not block a valley to a great depth, the outlet of the resulting lake will, on overflowing, cut down its course gradually and the lake will be slowly lowered. A great, prehistoric landslide, descending a slanting course of several miles on the Washington side, blocked the Columbia River about midway in its gorge through the Cascade Mountains and pushed the river toward the Oregon side; there the great river now has a cascading course among giant boulders and is striving to reestablish an even current and drain away its lake-like expansion that still remains next upstream from the obstruction; but as it has not yet succeeded in doing so, the slide must be of recent geological date. The name of the mountains through which the river has cut its deep gorge has been taken from the cascades of the river among the huge boulders of the slide.

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[1] Holland, T. H., The Landslip at Gohna, Garwhal. Rec. Geol. Survey, India, vol. 27, pp. 55-64, 1894.
Strachey, The Landslip at Gohna. Geog. Jour., vol. 4, pp. 162–170, 1894.
Lubbock, F., The Gohna Lake. Geog. Jour., vol. 4, p. 457, 1894.

Glacial Lakes

The great glaciers, which were formed on certain mountain ranges during the geologically recent, cooler and moister Glacial Period above referred to, scoured the bed rock of the highland valleys along which they crept, slowly and heavily, from higher to lower ground, and where the scouring was uneven, rock basins were excavated. Since the glaciers disappeared in the warmer and drier climate of the present, the basins that they excavated are occupied by lakes. Many Californian lakes are of this kind.

The modification of mountain forms produced by glacial erosion and the intimate association of lake basins with that extraordinary process may be made clearer by reference to Fig. 4. On the extreme left is shown the Preglacial form of a mountain range as produced by the prolonged action of ordinary weathering and streaming on an uplifted highland; not that all mountains had such forms in Preglacial time but that many of them had. The timber line was then at a high level, appropriate to the mild Preglacial climate. The dome-like summits give forth rounded, branching ridges and spurs, which separated correspondingly branching valleys; and down the continuously descending floors of the valleys, slender and nimble water streams ran in winding channels on the narrow valley floors.

In the left center, where the timber-line is lower by reason of a colder climate, a glacial system, consisting of several short branches heading in broad reservoirs and uniting in a long trunk, has taken possession of the upper part of a valley system and has reshaped the valleys to the satisfaction of the heavy and sluggish ice-streams. Each branch glacier has a concave surface in its gathering reservoir, but the trunk glacier assumes a convex surface as it sluggishly creeps down its course. Large as it is, all of its slow-moving volume is drained away by the slender ice-water stream that issues from a terminal ice cave. The several head glaciers have excavated great quarry-like cavities, known as cirques, in the valley heads, thus reducing the rounded mounts and ridges that enclose them to sharpened peaks and serrated crests; but unconsumed remnants of Preglacial dome-tops survive here and there. Each branch glacier preserves its individuality in the trunk; for ice streams do not mix their currents as water streams do. Hence the detritus dragged along from the narrowed spurs between the head reservoirs is seen in long ''medial moraines'' on the surface of the trunk glacier. That great glacier has transformed a narrow-floored, Preglacial valley into a strongly deepened and broadly opened but still steep-sided trough. The large size of the trough or ice-channel below the higher valley-side slopes is appropriate to the sluggish movement of the glacier, just as the small size of a valley-bottom stream channel is appropriate to the nimble flow of the water-stream.

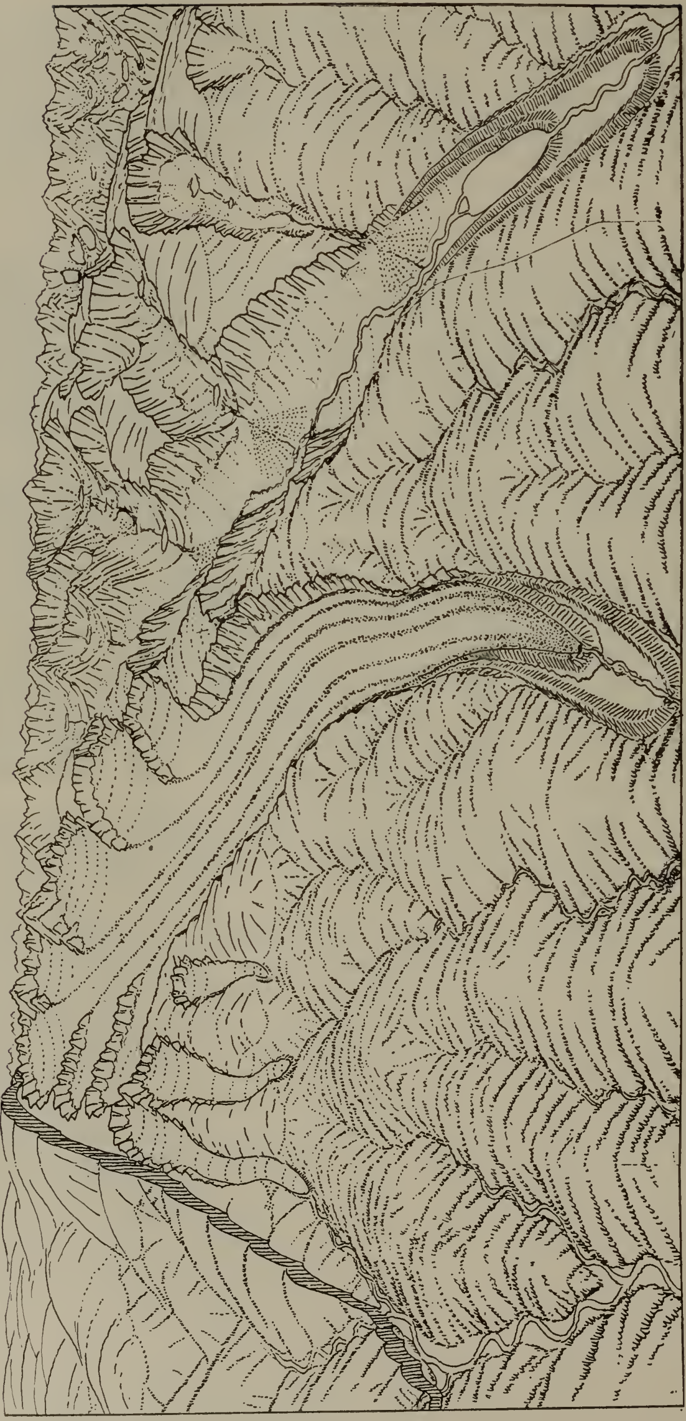

FIG. 4. Three-stage diagram, illustrating the glacial sculpture of mountains. On the extreme left, a non-glaciated mountain mass, with rounded spurs and narrow valleys, the work of ordinary erosional processes, chiefly weathering and streaming. Across the middle, same kind of mountains after they have been well modified by the glaciers which still occupy their valleys. On the right, the same, after the glaciers have disappeared, so that the cirques and troughs which they have excavated are exposed to view. Many small lakes are there seen, although no lakes existed in the mountains on the extreme left.

A small share of the detritus removed by the plucking and scouring action of the heavy, slow-creeping ice from the walls and floors of the cirques and troughs, as well as of that washed down upon the ice from the higher, ice-free surfaces, is deposited in a terminal moraine which loops around the end of the glacier in ridge-like form; but most of the removed detritus is carried away by the ice-water stream. The occurrence of a larger exterior terminal moraine indicates the presence at an earlier time of a larger glacier by which part of the cirque and trough excavation must have been done.

While these changes are going on, the parts of the range not occupied by glaciers are worn down lower by ordinary weathering and streaming without significantly changing their shape, to some such measure as is shown by the vertical face between the extreme left and the left center of the diagram.

The right half of the diagram exhibits the mountains as they appear after the glaciers have melted away in the milder climate of Postglacial time. The timber line is at a higher level again. The rock floors of the cirques are often scoured out in shallow basins, holding lakelets or tarns. Talus from the steep rock walls encroaches more or less upon the floors of the cirques and troughs. It is noticeable that the short side troughs which head in lateral cirques 'hang' above the much deeper floor of each great main trough. Streams, cascading down into the main trough, cut clefts and chasms in the lips of the hanging troughs, or hanging valleys as they may now be called, and build detrital fans below. The fans push the main trough stream toward the opposite side of the trough.

Small lakes may occupy shallow basins in the trough floor down stream from the cirques for a time after the disappearance of the glaciers; but many of them have been filled by stream-washed detritus which has built up or aggraded parts of the over-deepened floor in smooth flood plains or 'meadows.' The largest lake of the glacial system occupies the terminal part of the over-deepened floor, where the terminal moraine may aid in holding back its waters. The head of such a lake is partly filled in by the delta extension of the trough-floor flood plain.

Inasmuch as no great amount of talus has yet accumulated in the cirques, as the clefts cut in the lips of the hanging side valleys have not yet gained great depth, and as the terminal lake has not yet been completely filled by its growing delta, it must be inferred that the time since the disappearance of the latest glacial system is short compared to the time during which the valleys were occupied by that system as shown in the left-center of the figure, and shorter still compared to the time during which the mountain valleys, shown at the left end of the figure, were carved by ordinary weathering and streaming to the form they had before their occupation by ice.

The importance of glaciation in the production of lakes may be judged by the number and the size of such lakes in various parts of the world. For example, Okanagon, Arrow, Slocan and Kootenay in British Columbia, 60, 95, 23, and 68 miles in length, and the 65-mile Lake Chelan in Washington, all in valleys of the Columbia River system, occupy basins of glacial excavation. The same is true of the piedmont lakes of the Alps, including Annecy, Geneva, Thun-Brienz, Lucerne, Zurich, Constance, Ammer, Würm, and Chiem on the north, and Maggiore, Lugano, Como, Iseo and Garda on the south. Some of these lakes are over 1000 feet deep. They are all surrounded by beautiful mountain scenery, but the European examples have the additional and very picturesque attraction of long-established human occupation, while the American examples are for the most part in mountain wildernesses, scantily inhabited.

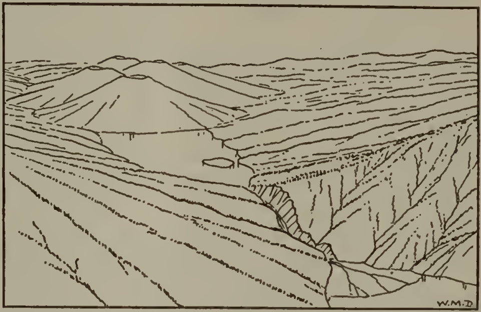

Fig. 5. A lake in a valley-head, above a group of volcanoes; the lake outlet has cut a notch in the divide at the head of the valley.

The great North American lakes, from those of the St. Lawrence system northwestward 2000 miles toward the Arctic Ocean, are all associated with the scouring action of the vast ice-sheets which covered northeastern North America in the Glacial Period, although it should not be asserted that they are wholly due to the excavation of their basins by ice action. Lake-basin production there may have been aided by warping of the earth's crust and by morainic obstruction of Preglacial river courses.

Volcanic Lakes

Volcanic cones or lava flows may obstruct valleys and produce lakes. Again an example may be taken from Africa: Lake Kivu, north of Tanganyika, is of this kind: its basin was apparently drained by a northward valley to the Nile before a group of great volcanoes barred the valley and turned its overflow southward via Tanganyika to the Congo, somewhat as in Fig. 5. The craters of extinct volcanoes may hold lakes. Among the most famous is Crater Lake in southern Oregon, 6 miles in diameter, 6240 feet in altitude and 2000 feet deep. It is surmounted by the 1000-foot cliffs of the enlarged crater or 'caldera,' which is believed to have resulted from the destruction of the upper part of the original cone, to which the name, Mt. Mazama, has been given. Three lakes lie in the craters of as many volcanoes next north of Rome. A number of similar but larger lakes are found in the volcanic cones of Java.

River-made Lakes

A river flowing in a serpentine or meandering course on a smooth flood plain frequently changes its course, leaving a narrow, curved lake in its previous channel, as in the left middle-distance of Fig. 6. Many such ox-bow lakes, as they are often called, are found in the flood plain of the lower Mississippi. A trunk river, which is well supplied with detritus from its headwaters, will build up or aggrade a flood plain near its banks more than at a distance to one side of them; those lower parts may then be occupied by marshy sloughs, as in the right foreground and left background of Fig. 6. Such a river may, indeed, build up its flood plain so actively that its side streams which build up their plains less rapidly are converted into lake-like water-bodies near their junction with the trunk river, as in the right background of Fig. 6. The branches of the Red River of Louisiana and of the lower Danube in Russia afford examples of this kind. Basins are sometimes enclosed or divided by the fan deltas of entering streams.

Artificial Reservoirs

Reservoirs, formed by building dams across valleys, closely resemble natural lakes. California possesses many such water-bodies.

Lake-like Bays and Lagoons

Arms of the sea, more or less completely land-locked, are also somewhat lake-like. It should be understood that Figs. 2 to 8, 13 to 15, 21, 25, 26, and 29, are not pictures of actual lakes and landscapes, but only ideal diagrams, drawn in a highly conventionalized manner with the object of supplementing the explanations of the text.

Lakes Are Ephemeral

It follows from the above principles that lakes should be regarded as representing only a passing phase in the action of the antagonistic processes that are concerned in the shaping of the land surface. The land-shaping processes are as a rule so slow in their action that we speak, properly enough from the viewpoint of human history, of the 'everlasting hills,' and we take little or no account of the changes suffered by most land forms—such as Mt. Sinai or the Seven Hills of

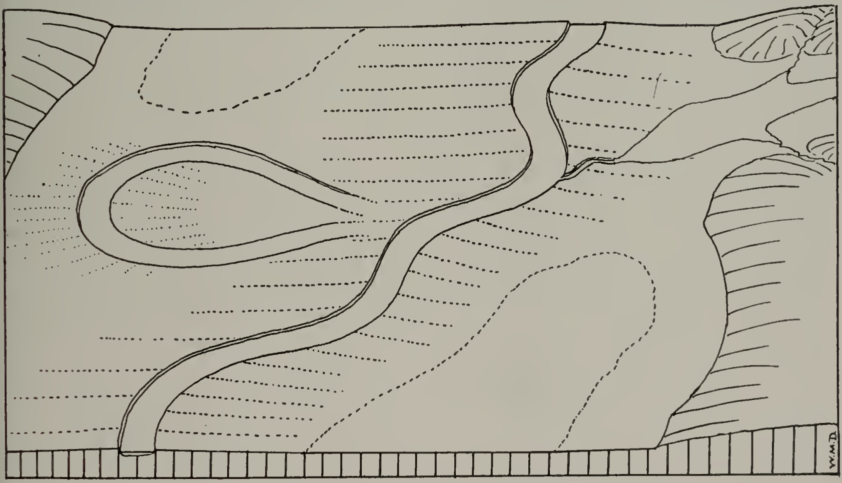

FIG. 6. Diagram of river-made lakes and sloughs.

Rome—during the latter part of the human period of geological time. But the student of geology must free himself of the idea that land forms are permanent, however fitting such an idea may be in the study of human history; he must strive to look on land forms as old Mother Earth herself would look upon them; that is, as forms which are, in terms of earth history, undergoing relatively rapid change.

Every element of the landscape should therefore be studied as representing a mere transitory stage of the systematic changes by which land forms pass from their earlier to their later, from their initial to their ultimate form. In such study those water forms which we call lakes are, because of the delicacy with which water assumes a level surface, very helpful in showing where hollows or basins in the land surface occur, and the changes in the outline and area of lakes are therefore reflections of the associated changes in the form of their basins. Thus conceived, the study of lakes gains much interest to an observant traveler; and thus equipped with a general understanding of the lakes of the world, the observer is better prepared for an appreciative understanding of the lakes of his own State.

Part II. THE LAKES OF CALIFORNIA

Sources of Information

California possesses a large number of lakes and lake-like water bodies of the various kinds above explained. The account of them presented below is believed to be more complete than any other that has yet been prepared. It has been made up in part from personal observation,[2] but much more largely from the study of articles by other observers and also from the examination of large-scale topographic maps. Although much information has been thus secured, the knowledge of California lakes is as yet by no means complete. It is therefore hoped that what is here told about those which have already been examined may lead to new investigations. Many of the less known lakes are unquestionably fertile subjects for further study, such as has already been given to the Alkali Lakes of Surprise Valley by R. J. Russell, to Medicine Lake of the Modoc lava beds by M. A. Peacock, to Sierran lakes of glacial origin by Eliot Blackwelder, to the glacial and volcanic lakes of Lassen Volcanic National Park by Howel Williams, and to other lakes by various investigators whose instructive essays are cited below. In case new studies of our lakes should include good photographs, preferably from an elevated point of view so as to show the whole breadth of the water surface in its setting with its near as well as its far shore, the State Division of Mines would be glad to add prints of such views to its growing collection of landscape portraiture.[3]

Although by no means all the lacustrine water bodies of the State are named on the following pages, it is believed that examples of all the different kinds of lakes that California possesses are included. Practically all the lakes named are shown on the large, two-sheet outline map of the State, published in 1929 by the U. S. Geological Survey on a scale of 1 : 500,000. For the sake of brevity the location of various lakes is concisely stated in relation to neighboring mountains, rivers or other large natural features, and occasionally in relation to near-by towns or cities. Surface dimensions are given roughly in miles as taken from the topographic maps of the U. S. Geological Survey, from the charts of the U. S. Coast and Geodetic Survey and from other sources; altitudes and depths are given, not always accurately, in feet.

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[2] The study of lakes has long engaged the author's attention; see his essay "On the Classification of Lake Basins," Proc. Boston Soc. Nat. Hist., vol. 21, pp. 315-381, 1882, and his shorter article on the same subject in Science, vol. 10, pp. 142-143, 1883.

[3] The address of the State Division of Mines is: Ferry Building, San Francisco, California.

Lakes in Young Fault-Block Basins

The Modoc lava field, which occupies a large area in the northeastern part of California with a thickness of 4000 or 5000 feet has, according to a recent study by Peacock,[4] been broken into several long fault blocks 10 or 20 miles in breadth, trending about north-south and crossing the northern border of the State into Oregon; the blocks have been gently and somewhat unevenly tilted so that their upraised edges form bold, little eroded scarps, from 200 to 400 feet or more in height. Three lakes occupy the down-tilted areas beneath the scarps, somewhat as in Fig. 7, and it would be difficult to find better examples of their kind. Clear Lake, one of three of that name in the State, lies 10 miles south of the Oregon line; it has been somewhat enlarged as a reservoir for irrigation and now measures 8 by 3 miles. Farther west is Tule Lake, formerly known as Rhett Lake, at an altitude of about 4140 feet. In 1884, it had an area of 184 square miles; in 1924, its area was halved; in 1930, it was "a small and shallow pond" which appeared to be vanishing. Still farther west is Lower Klamath Lake, 4175 feet in altitude and 27 by from 3 to 8 miles in size, of which only half lies in California. It also is diminishing in area, and much of it now is a reed marsh. The most probable cause for the diminution of Tule and perhaps of Lower Klamath Lake also is that their underground discharge is increasing. This, taken in connection with the steepness of their limiting fault scarps, suggests a very recent date for the faulting.

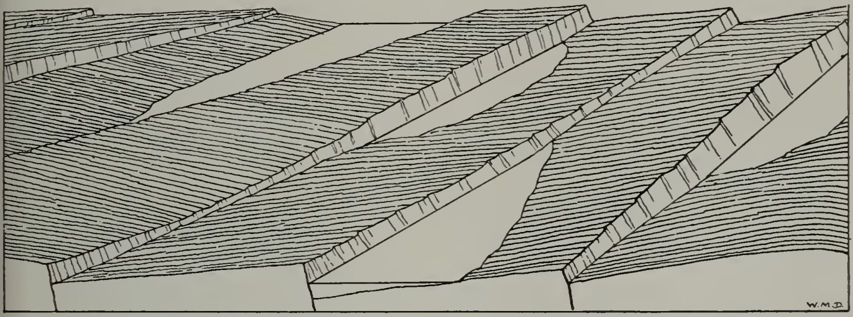

FIG. 7. Diagram of diversely tilted fault blocks, with lakes occupying the depressions.

A small example of a water-filled fault-basin is seen in Marlette Lake, as described by Reid.[5] It is 2 miles long, at an altitude of 8000 feet, in the broad-topped Carson range, the uplifted mountain block next east of Lake Tahoe in Nevada. The basin is so little filled with detritus that its origin would seem to be geologically recent.

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[4] Peacock, M. A., The Modoc Lava Field, Northern California. Geog. Rev., vol. 21, pp. 259-275, 1931.

[5] Reid, J. A., The Geomorphogeny of the Sierra Nevada Northeast of Lake Tahoe. Univ. Calif. Publ., Bull. Dept. Geol. Sci., vol. 6, pp. 89-161, 1911.

Lakes in Aggraded Fault-Block Basins

Many intermont troughs and basins produced by strong faulting or flexing are found among the uplifted fault-block mountains of the Great Basin between the Wasatch mountain range of Utah and the Sierra Nevada, and a number of them are included within the arid northeastern and southeastern corners of the Golden State. The adjoining mountains are as a rule well dissected by deep valleys and the troughs or basins are therefore heavily filled or aggraded with down-washed detrital deposits which form nearly level plains, commonly known as 'valleys,' as in the foreground of Fig. 8. Relatively shallow playa lakes, many of them without outlets because of the dryness of the climate, lie on the lowest part of the plains.

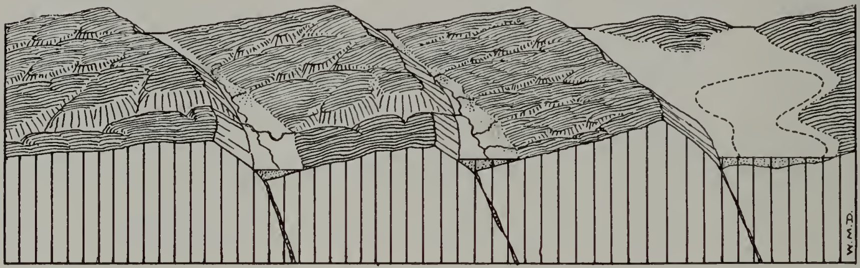

FIG. 8. Diagram of the great fault blocks of the northern Sierra Nevada, with the plain of Honey Lake on the east.

Playas are divided, according to Foshag, into two classes, water-tight or saline and leaky or dry. Water-tight playas are "salt encrusted areas, covered by a sticky tenacious mud when wet or a light fluffy soil when dry. During the rainy season they are often covered by shallow bodies of water and for the greater part of the year they are more or less moist. The water table seldom lies more than a few feet below the surface. The dry playas are entirely dry, only during periods of excessive or prolonged rainfall in the encircling ranges is water present on the surface for more than a few days at a time. Their surface consists of hard, smooth, sun-baked clay without visible concentration of salt."[6]

A typical example of the latter class is found in the shallow and variable Honey Lake, which lies on a broad and arid detrital plain of aggradation next below the great east-facing scarp of the northern Sierra Nevada, not far west of the Nevada line, somewhat as shown at the right end of Fig. 8. The scarp is believed to be the modified face of a great fault which constitutes one of the most distinctive features of the mountain range. It may therefore be believed that the Honey Lake area has been depressed and aggraded, while the strongly uplifted mountain mass was eroded. Recent slight movements on the fault are to be associated with several weak earthquakes felt there between 1880 and 1885, and in 1921.[7]

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[6] Foshag, W. F., Saline Lakes of the Mohave Desert Region. Econ. Geol., vol. 21, pp. 56-64, 1926.

This interesting lake is 3950 feet in altitude, 15 by 9 miles in area during wet winters, and yet then only from 1 to 4 feet in depth. Its water is alkaline and the lake is adjoined by barren alkaline flats. The surrounding plain is available for agriculture only where it can be irrigated. During dry summers the lake diminishes and occasionally vanishes, leaving an utterly barren playa with a surface nearly as smooth as that of the winter lake. The region then presents an extreme contrast to its condition when it was submerged to a depth of 350 feet, some thousands of years ago, by the northwest arm of a great inland sea of very irregular outline, to which the name of Lake Lahontan has been given. The shorelines made by its waves are still to be traced on the enclosing mountain slopes, but since then it has been evaporated away. One must therefore infer that the climate of the present epoch is warmer and drier than that of the epoch when Lake Lahontan was flooded. The climatic changes thus recorded probably occupied scores, perhaps hundreds of thousands of years; yet they are but a fraction of the time represented by the heavy aggradation of the Honey Lake intermont plain with detritus supplied by the downwearing of the adjoining mountains.

In the extreme northeastern corner of the State is the flat floor of a down-faulted and heavily aggraded trough, of the kind shown in the foreground of Fig. 8, known as Surprise Valley, Fig 9, over 40 miles long and 8 miles wide, with an altitude of about 4700 feet. It lies between the great uptilted, and immaturely dissected lava-bed fault blocks known as the Warner Range on the west and as the Hayes Canyon Range of northwestern Nevada on the east. On this flat floor

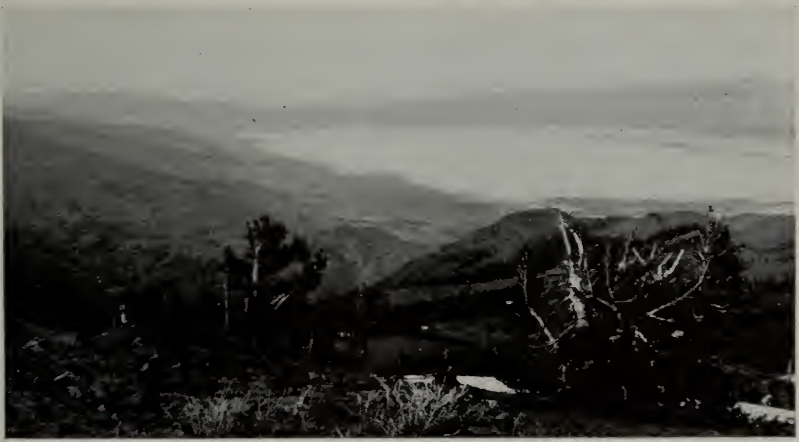

Photo by R. J. Russell.

FIG. 9. Looking northeast from crest of the Warner Range over Surprise Valley.

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[7] Kemnitzer, W., The Eagle Lake Earthquake of July 21, 1921. Seism. Soc. Amer. Bull., vol. 11, pp. 192–193, 1921.

lie three shallow and variable sheets of water which are named on the U. S. Topographic Map of their district as Upper, Middle, and Lower Alkali Lakes; but according to R. J. Russell, who has given an excellent description of them,[8] they are hardly known as lakes to the people who live on the surrounding plain. Two lakes may be seen from the crest of the Warner Range, looking northeast, Fig. 9, and southeast over the plain of Surprise Valley. Like Honey Lake, these shallow water sheets attain their greatest depth of a foot or two after winter rains; they almost or quite disappear in the summer, thus laying bare their silt beds or playas of the dry class. In winter when their water sheets are frozen over and in summer when their beds are dry and hard-baked, they may be driven over.

These lakes are bordered along their eastern or leeward shoreline by rather broad belts of salt flats, from the brine of which salt is won for local use, and sand dunes. Along their western side is a broad belt of grasslands, subject to temporary flooding from the mountains in the wet season. Here, marked by groups of willows, numerous springs bring forth the ground water that is fed by rainfall on the Warner Range. Some of the springs are hot; others bring fine silt to the surface and build small mounds around their vents, locally known as 'mud volcanoes.' The grassland belt is the best farming area of the intermont plain; as seen from the mountains its fields have a checkerboard appearance, in pleasing contrast to the uncultivated and almost valueless adjoining surface.

Like other lakes of their kind in the Great Basin these Alkali Lakes, the vague shorelines of which migrate with the winds, are the successors of an ancient and much larger lake, which flooded a large part of the intermont basin plain and to which the name, Surprise Lake, has been given. Its shorelines on the mountain slopes show it to have had a length of 70 miles and a depth of 550 feet. The climate then must have been cooler and rainier than now.

Goose Lake, as described by R. J. Russell[9], is another shallow water sheet, which occupies, at an altitude of 4800 feet, a large part of a moderately down-faulted trough below the western slope of the above-named Warner Range. It measures 30 by 10 miles, but one-third of its length extends into Oregon. A shallow gorge eroded through the lava beds on the south indicates that the lake formerly had a somewhat persistent discharge to Pit River, which flows westward through the highlands between Mt. Shasta and Lassen Peak to the Sacramento; but at present the lake overflows only when the water is brushed southward by a strong north wind, as happened in 1910.

Farther south, close to the eastern base of the Sierra Nevada lies Mono Lake, 6420 feet in altitude and 12 miles in diameter. This lake have been described by I. C. Russell[10]. It is believed to occupy a basin of depression, produced by down-faulting with relation to the up-faulting of the adjoining mountain range, but the enclosure of its waters may be due, at least in part, to volcanic barriers. As in the case of the Nevada lakes above described, a much larger lake, known by its high-standing shore lines, formerly occupied the basin in which Mono Lake now stands. The beauty of the present lake is much enhanced by the grandeur of the mountain scenery on its western side. The famous Tioga Road makes its descent there from the Sierra crest in a deep ravine. A considerable area south and southeast of the lake is covered with volcanic cones and lava flows, which have presumably diminished the extent that the lake might otherwise have. A volcanic island in the lake and several glacial moraines near it on the west will be referred to below in the sections on lakes of volcanic and of glacial origin.

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[8] Russell, R. J., The Land Forms of Surprise Valley, Northwestern Great Basin. Univ. Calif. Publ., Geogr, vol. 2, pp. 323–358, 1927.

[9] Russell, R. J., Basin Range Structure and Stratigraphy of the Warner Range, northeastern California. Univ. Calif. Publ., Bull. Dept. Geol. Sci., vol. 17, pp. 388–496, 1928.

[10] Russell, I. C., Quaternary History of Mono Valley, California. U. S. Geol. Survey Eighth Ann. Rept., pp. 281–394, pls. 17, 19, 21, 1889.

Still farther south where the climate is even warmer and drier, a number of dry lake-beds on the lowest part of many intermont plains may be here instanced as showing that lakes were formerly more abundant than now, and as thus indicating the cooler and moister climate of that earlier time. South of Mono Lake 110 miles in Owens Valley and again at the eastern base of the Sierra Nevada, is the shallow Owens Lake, 3569 feet in altitude, 15 by 9 miles, formerly larger, now mostly reduced to a saline incrustation: this is therefore a playa of the saline class. To the southeast is the dry plain or playa of China Lake, 2124 feet in altitude, 7 by 2 miles; still farther east between the Argus and Slate ranges, is Searles Lake, 11 by 6 miles, 1623 feet in altitude, now heavily crusted over with a sheet of salt but containing a body of brine below, in consequence of which it has become the seat of an important chemical industry: this is another example of a saline playa. Again farther east, on the desert floor of the intermont depression known as Panamint Valley between the Slate and Panamint ranges, is Dry Lake playa, a white plain of saline clay, measuring 17 by 2 or 3 miles at an altitude of 1050 feet; another playa lies farther north in the same valley. Beyond Panamint Valley is the more famous Death Valley, of similar nature and again containing a playa of saline clays, but lying for the most part below sea level.

All of these now extinct lakes were, in the Glacial Period, on the course of the then enlarged Owens River, and each one of them except the last named then expanded to much greater area and depth than its saline successor of today and rose to the level of the lowest sag in the barrier to the east: thus each lake, as Gale, cited below, was the first to point out, overflowed to the next lower member of the series. At the level of each sag of overflow a shore line was more or less clearly marked around the lake by wave-built beaches, still discontinuously traceable. The lake of Death Valley, believed to have been fed by the overflow from Panamint Lake across Wingate Pass, does not appear to have risen to a sag of overflow as it was the farthest member of the series; hence its level, being dependent on inflow and evaporation, fluctuated up and down. Its faint shore lines have been detected at a number of points and indicate that it had a length of two or three score miles when at its highest level.

In the southern part of the Inyo Range, next east of the southern Sierra Nevada, are two down-faulted and aggraded 'holes,' known as Saline and Deep Spring Valleys. In each of them a saline lake or incrustation lies near the scarp of down-faulting. The first has been described by Gale[11] and by Knopf[12]; the second by Miller[13].

Many playas of the dry kind, representing vanished lakes mostly of moderate size, as in Fig. 10, might be mentioned as occurring in the arid southeastern part of the State. Like all their fellows these playas are covered with a very shallow sheet of water after heavy rains, and their clay floors are then impassable; but when the water is evaporated in the dry season the clay surface is firm and smooth, except where ridged and hard-baked ruts remain to mark the path of adventurous cars. One of the playas, known by the generic name of Dry Lake, 17 by 2 miles, is crossed by the Santa Fe railroad in its traverse of the northern part of the Mohave Desert. Another known as Bristol Lake, on the same railroad line farther east, is varied by the invasion of a black and ragged lava flow from a small volcanic cone on the west. Two smaller playas north of that railroad are crossed by the Cave Springs road to Death Valley. Others are too numerous to specify. It is on the level surface of a dry playa that the deceptive imitation of a lake, known as a 'mirage,' is developed on calm summer days. It is due to the super-heating of a thin layer of air next to the ground, so that when it is looked at from one side the light of the farther sky is reflected from it to the observer. As such reflection is a normal characteristic of true lakes, an inexperienced observer is likely so to misinterpret it in the desert.

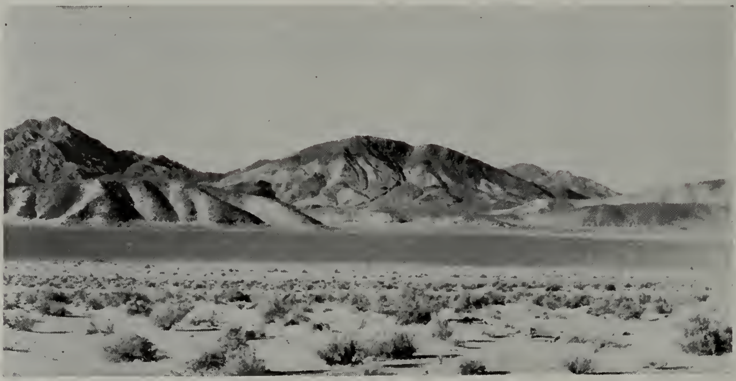

Photo by Eliot Blackwelder

FIG. 10. Silver Lake playa, in the southern part of a long depression which, farther north, is known as Death Valley.

Lake Elsinore, 5 by 1 or 2 miles, 1220 feet in altitude, is a shallow, brackish and variable water sheet lying in a faint depression at the highest part of the long, aggraded fault trough next northeast of the Santa Ana Mountains, 60 miles southeast of Los Angeles. Whether the shallow basin of the lake is determined by small and recent movements on faults, or by detrital fans washed in from the enclosing mountains has not yet been fully decided. The lake occasionally rises enough, in years of exceptionally heavy rainfall, to overflow northward by Temescal Creek along the fault trough to Santa Ana River. The scanty water supply of its district is made the most of in developing its scenic attractions.

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[11] Gale, H. S., Salt, Borax and Potash in Saline Valley, Inyo Co., Cal. U. S. Geol. Survey Bull. 540, 1914.

[12] Knopf, Adolph, A Geologic Reconnaissance of the Inyo Range. * * * U. S. Geol. Survey Prof. Paper 110, 1918.

[13] Miller, W. J., Geology of Deep Spring Valley, Calif. Jour. Geology, vol. 36, pp. 510–525, 1928.

Ancient Lakes of Intermont Basins

As the foregoing pages have presented accounts of playa lakes which vary with the seasons and of ancient lakes which indicate past variations of terrestrial climate through thousands of years, a brief mention of certain basin plains may be added which appear to indicate the occasional occurrence of still more ancient lakes. The part of the Sierra Nevada west of the above-described Honey Lake has been explained by Diller [14] as consisting of several west-sloping fault blocks with east-facing and more or less modified fault scarps, somewhat as represented in Fig. 8. Northeasternmost is Diamond Mountain block, some 40 miles in length, with a strong scarp, 2000 feet high overlooking the Honey Lake plain. The surface of the block slopes gently southwestward for some 20 miles into a long depression at the base of the next or Grizzly Mountain block; and that block, also sloping southwestward, is followed in its turn by the larger Claremont block which slopes down to the vast plain of the Great Valley. The inter-block depressions are aggraded with detrital plains, known as Indian and American valleys.[15] Lakes may have existed there intermittently during the time of slow faulting but none are present today. A larger example of an intermont basin which may have held a shallow lake at times during its aggradation is found in the so-called Sierra Valley, a broad plain which lies southeast of Indian and American valleys and which will be described below in connection with Lake Tahoe after the section on volcanic lakes.

Similar inferences as to the former occurrence of temporary lakes may be made with respect to several smaller intermont basin plains in the northern Coast Ranges, such as Potter and Long valleys, as well as to the somewhat larger basin-plain now mostly submerged beneath the waters of Clear Lake, 100 miles north of the Golden Gate, of which further account is given in the second-following section. All of these plains may have been intermittently flooded by shallow lakes during the slow down-flexing or down-faulting of their basin floors, but there is no sufficient reason for thinking that the basins were so suddenly produced that they at first held deep lakes which were then, after their rapid production ceased, slowly filled in with detritus and converted into plains as their outlets were cut down. Whatever lakes occupied the basins are best interpreted as shallow and temporary features compared to the associated fault-block mountains and basin plains.

The same statement holds good for the many longer and larger intermont basin plains of the southern Coast Ranges, of which typical examples are found in the Panoche and the Quien Sabe valleys, the first measuring 10 by 4 miles at an altitude of 1300 feet, the second 8 by 1 or 2 miles at an altitude of 1600 feet; both are drained by small

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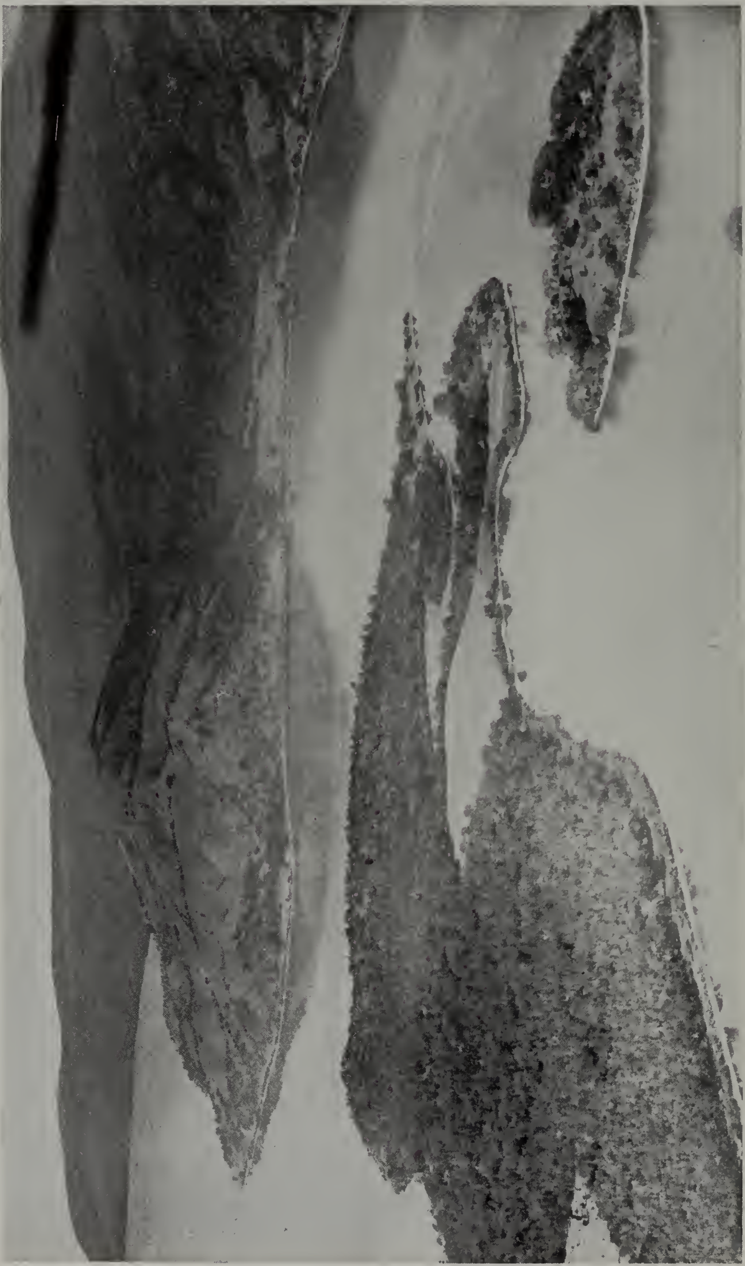
[14] Diller, J. S., Geology of the Taylorsville Region, California. U. S. Geol. Survey, Bull. 353, 1908.

[15] A view of the Indian Valley plain and of the dissected fault scarp to the west of it is given by Diller in Plate LI of his report on the Geology of the Lassen Peak District. U. S. Geol. Survey Eighth Ann. Rept., pt. 1, pp. 395–432, 1889.



Air-view by G. E. Russell, San Francisco

FIG. 11. The Narrows of Clear Lake, looking north.

streams through mountain gorges. Apparently on account of the southeastward decrease of rainfall, one of the larger southern examples, known as the Carrizo Plains, is peculiar in lacking a stream outlet. It is enclosed by a broad mountain mass on the west and on the east by the Temblor Range, the latter being one of the latest linear upheavals by which the breadth of the Coast Ranges has been increased at the expense of the Great-Valley plain. The smooth, treeless Carrizo surface, mostly given over to wheat fields, has been built up in faintly concave form by the inwash of detritus from the valleys eroded in the inclosing ranges; so that it now has a length of 40 miles, a width of 5 miles and an altutude of from 1950 feet at its middle to about 2600 at the ends. Over its lowest, medial part is spread Soda Lake, 5 miles long; a shallow water sheet after winter rains, a white and barren desert during the hot and dry summers. It lies near the western border of the plain because of the more abundant inwash of waste from the Temblor Range on the east.

Sag Ponds

Here and there along the Elsinore fault or rift and still more frequently along the more famous San Andreas rift, a slight movement on which caused the San Francisco earthquake of 1906, numerous little water-holding depressions, known as ''sag ponds,'' mark the sites of local subsidences. One of the largest of its kind is Lake Elizabeth, about 2 miles long, on the San Andreas rift in the western part of the Mohave Desert, 50 miles northwest of Los Angeles. An unnamed sag pond, a mile in length, occurs on a rift at the base of the recently up-faulted El Paso Range, 6 miles northwest of Randsburg.

Landslide Lakes

The chief Californian lake of this class is Clear Lake,[16] which floods the greater part of an intermont basin plain in the northern Coast Ranges. It has given name to the county, in the center of which it lies. Long previous to the production of the lake the plain, measuring about 25 miles northwest-south, by 15 miles in greatest width, was drained by two outflowing streams, the divide between which may have been marked by low mountain spurs near the lake middle. One of the streams (Cold Creek) had cut a deep gorge westward through an enclosing range to Russian River, which led it to the Pacific 55 miles north of the Golden Gate; the other (Cache Creek) had cut a longer and deeper gorge eastward through the opposite range, which led it to the Sacramento and thus to the head of San Francisco Bay. After a time the eastern stream was crossed near its gorge entrance by a small lava flow, and its headwaters were thus diverted to the western stream.

At a still later date a landslide, descending only a few centuries ago from the southern side of the western gorge near its mid-length, filled it up for a mile or more to a higher level than that of the lava flow near the far end of the basin plain. The obstruction was so effec-

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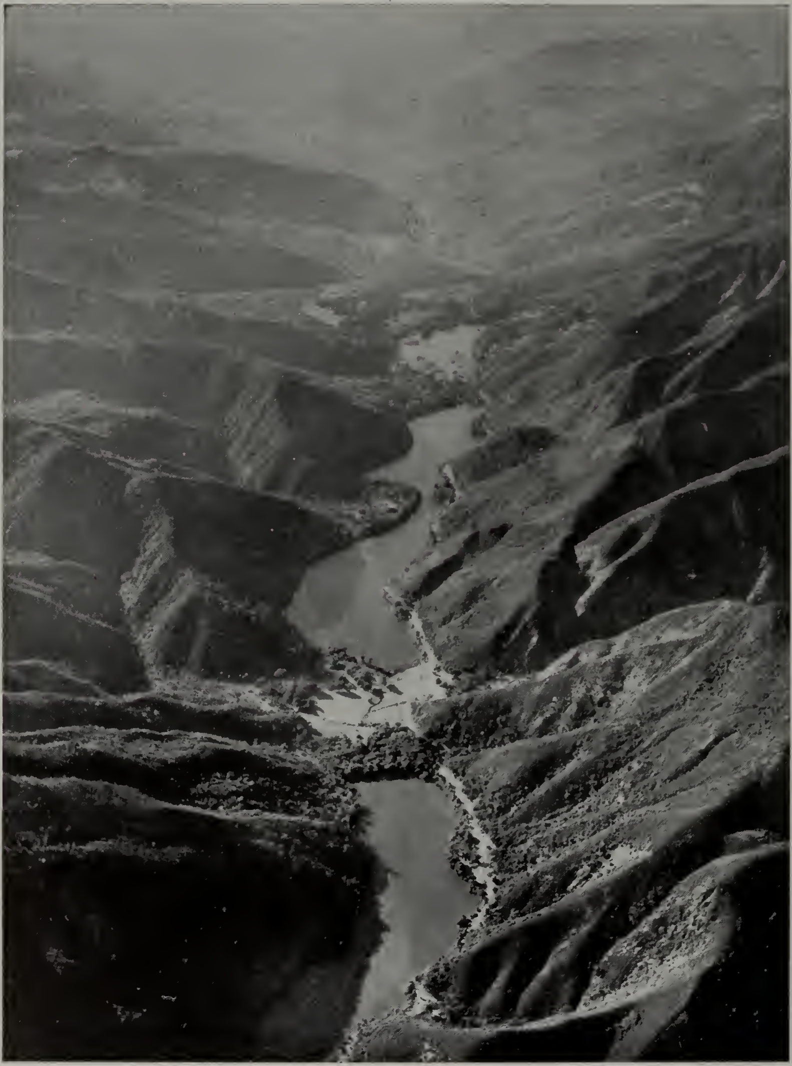
[16] This account is condensed from a study of Clear Lake by the author, as yet unpublished, in the preparation of which much assistance has been received from Olaf P. Jenkins, Chief Geologist, Division of Mines. It was he who first found the trench through the lava flow, which has proved to be of so great significance in the history of the lake.



Air-view by Erickson.

FIG. 12. The Blue Lakes, in the former outlet gorge of the Clear Lake basin plain. The obstructing landslide is just beyond a white field in middle distance. The two lakes are separated by the inwashed deltas of side streams nearer the foreground.

tive that a lake, fed by the streams that flowed into the basin, slowly rose higher and higher behind the slide, spreading over more and more of the plain, until it overflowed across a sag in the lava flow. The overflowing stream thereupon cut a trench (Redbank Gorge) across the flow, thus lowering the lake about 60 feet below its highest level, giving it a discharge through the eastern gorge, and re-enforcing the previously beheaded eastern stream (Cache Creek). The reduced lake now stands at an altitude of 1310 feet, with a size of 19 by 8 miles and a maximum depth of about 50 feet. Two narrow eastern arms are separated from the main western body at a picturesque Narrows, Fig. 11, near the lake mid-length. Had there been no outlet for the lake through the eastern gorge, the lake would probably have risen till it overflowed across the landslide in the western gorge and its outlet stream would very likely have washed away most of the slide in a destructive flood centuries ago, thus draining the lake and laying bare again the intermont basin plain. But such western overflow was effectively prevented by the presence of the eastern gorge. The landslide is of so enormous a volume that its removal by surface rills or leakage of ground-water is out of the question.

Since the formation of the lake its slender arm that at first occupied the part of the western gorge back of the landslide has been cut off from the main body of the lake by the broad delta of Middle Creek, which comes from the north; and the arm has been further shortened by the delta of Scott Creek, which entered it from the south. Its short remainder is now divided by the combined deltas of two wet-weather side streams, thus forming the picturesque little Blue Lakes, Fig. 12, beautifully enclosed by the steep sides of the gorge. These lakelets, therefore, belong in the class of lakes, the basins of which are barred by deltas, as will be told in a later section.

Clear Lake was artificially modified 20 years ago by the building of a 30-foot dam at the entrance to the eastern gorge and by the blasting out of a rocky barrier to a few feet greater depth near the entrance of the eastern outlet stream into the trench through the lava barrier, with the object of storing greater volume of water supplied by the winter rains and of withdrawing it to lower than ordinary lake level for irrigation of rice fields in the Yolo basin of the Sacramento in the summer. In consequence of these changes, the lake surface now usually stands a few feet below the level of the shore beaches that were formed before the changes were made. Unfortunately, the moderate rainfall of the region, 25 or 30 inches a year, does not supply the inflowing streams with much more water than is lost by evaporation, 53 inches in a year, from the lake surface, and therefore the outflow available for irrigation is usually small.[17]

The various changes that have taken place in the drainage of the basin have had a curious effect on the distribution of river fish. In consequence of the lava flow by which the head of the eastern stream was cut off and diverted to the western stream, one must infer that various species of fish belonging to the Sacramento system were transferred to the Russian River. This inference finds support in a study by Snyder who, nearly a quarter-century before the existence and the effects of the lava flow were discovered, pointed out that the fish of Russian River are like those ''of the upper courses of the streams tributary to the Sacramento which flow from the western side of the Great Valley, the channel forms common to the main river [Sacramento] being absent'' from the Russian River; and he therefore concluded that ''the fish fauna of the Russian River was probably derived from the Sacramento,'' for ''the Sacramento, a vastly larger and probably older system, not only contains all the [12 indigenous] fluviatile species known from the Russian River, but also others not there represented.''[18] If the history of Clear Lake involved only its blockade by the landslide in the western gorge and the resulting shift of west-flowing stream through the eastern gorge to the Sacramento system, the above prophetic statement would have lacked confirmation; but the discovery of the lava flow and its effects confirms the prophecy by giving it a sound geological foundation.

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[17] Chandler, A. E., Water Storage on Cache Creek, California. U. S. Geol. Survey Water-Supply Paper 45, 1901.

A fine highway, ascending the lower part of the western gorge from Russian River valley, surmounts the landslide, skirts the Blue Lakes, crosses the delta plain of Middle Creek, follows the north shore of the main body of the lake, passes the Narrows and continues along the northern and shorter one of the two eastern arms. A side road, zigzagging up the mountain slope north of the main body affords a fine view of the lake and of the Konocti group of volcanoes, which reach altitudes over 3500 feet, adjoining the longer or southeastern lake arm. A considerable area of the basin plain, known as Big Valley, adjoining the main body of the lake on the south, is largely devoted to fruit raising.

This fine lake, the only lake in the northern Coast Ranges, is perhaps even more largely resorted to by summer visitors than Lake Tahoe in the Sierra Nevada. Its attractive scenery is therefore of a considerable esthetic value to the State, while its fisheries are of growing economic value. Moreover, in consequence of its production Lake County has become the home of many waterfowl which would otherwise not remain there.

Several other smaller lakes of landslide origin occur in the deeply eroded valleys of the Warner Range, already referred to as forming the western boundary of Surprise Valley in the extreme northeastern corner of the State. They have been well described by Russell,[19] who explains that their formation is favored by the occurrence of weaker volcanic beds under a capping of resistant basalt, so that the basalt, forming a 'rim rock' at the top of the valley sides, is sapped by the more yielding beds below it. One of these small lakes which, like the above described much larger fault-basin lake some 40 miles farther west, repeats the name of the still larger landslide lake in the northern Coast Ranges, measures only $\frac{1}{2}$ by $\frac{1}{8}$ miles, with a depth of 90 feet; it stands at an altitude of 5750 feet in a canyon 1000 feet deep in the western slope of the range. Two landslides, one from each side of the canyon, form its barrier; their scars are fresh-looking and the delta of the inflowing stream is small; hence the age of the lake is perhaps not over a century. Blue Lake, 10 miles farther south, is of similar and recent origin, but it is barred by a single slide. These two lakes drain to Pit River. Lost Lake lies in a sharply eroded canyon on the eastern slope of the same range at an altitude of 7400 feet; it is about 1700 feet in diameter; its delta is 50 per cent larger than its own area, and the scar of its landslide, a mile in length, is less fresh than those of Clear and Blue lakes. The outlets of these lakes all cascade down over the great boulders of their barriers.

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[18] Snyder, J. O., The Fauna of Russian River, California, and Its Relation to that of the Sacramento. Science, vol. 27, pp. 269–271, 1908.

[19] Russell, R. J., Landslide Lakes of the Northwestern Great Basin. Univ. Calif. Publ., Geog., vol 2, pp. 231–254, 1927.

Jess Valley is again, according to Russell, the filled-in and drained bed of a much older and larger landslide lake in the valley of Pit River, between Clear and Blue lakes, where that river, passing from the western base of the Warner Range, cuts a gorge through another up-faulted block of lava beds of less altitude. The nearly level surface of the valley measures 6 by 2½ miles at an altitude of 5300 feet. Its obstructing slide filled the gorge for half a mile and is estimated to contain 45,000,000 cubic yards of detritus. Several other meadows of similar origin are found farther down the gorge; but they are now trenched by the river, so that their remnants form terraces on the gorge walls. The same experienced observer reports that Eagle Lake, 30 miles northwest of Honey Lake, 5115 feet in altitude and 12 by from 2 to 4 miles in size, appears to be barred on its southeastern side by a landslide; if so, it would rank next after Clear Lake. He adds that this lake rises and falls without regard to rainfall, and that when it sinks numerous springs flow actively from the outer slope of its apparent barrier and supply streams that reach Honey Lake. This suggests that the barrier is of porous nature, as a landslide might well be, and that the water passages through it are intermittently closed and opened.

The small Kern Lakes, in the southern part of the remarkably rectilinear, north-south canyon of Kern River, west of Mt. Whitney in the southern Sierra Nevada, have been described by Lawson.[20] The southern one was originally barred by a rock slide which came down from the eastern wall of the canyon about 100 years ago and obstructed the canyon floor for a mile of its length; but the lake, now less than a mile across, has been much diminished by in-washed detritus. Kern River, continuing through the lake, has barred off its course by the high edge of its flood plain. The northern lake, a mile farther upstream, diminished by Kern River delta to a half-mile diameter, is separated from the lower lake by the detrital fans of two small streams from the east: it is believed that these fans were much increased in size in 1868, and that the separation of the upper from the lower lake dates from that year. Mirror Lake in the Yosemite Valley is also of rock-fall origin and will be described in the latter part of the next section.

A small lake, now extinct, was formed by a landslide in Grapevine Canyon, where the Ridge Road leading from Los Angeles northward to the central part of the State enters the southern part of the Great-Valley plain. This canyon is cut in the mountains which there curve around from the Sierra Nevada on the east to the Coast Ranges on the west; and the slide came from the mountain flanks on the west side of the canyon mouth. The uneven surface of the down-creeping mass is distinctly unlike the smooth and undisturbed slopes on either side of it. The lake which rose back of the slide has long since been filled with detritus, through which as well as through the slide itself a gorge has now been eroded. The thousands of travelers who daily follow the Ridge Road cross over the lower part of the slide, where the impetus of its flow banked it up against the east side of the canyon mouth; the road there makes a winding descent to the gently sloping "fan" of flood-washed stony and bouldery detritus that slants far forward on the vast plain. Another ancient slide seems to have blocked the stream farther up the same canyon near Old Fort Tejon.

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[20] Lawson, A. C., The Geomorphogeny of the Upper Kern Basin. Univ. Calif. Publ., Bull. Dept. Geol. Sci., vol. 3, pp. 291–376, 1904. See pp. 343–345.

Two small landslide lakes are known in the northern corner of Lassen Volcanic National Park. One, Manzanita, originated according to Williams, cited below, about 200 years ago when a slide known as the Chaos Jumbles descended from Chaos Crags and blocked the valley of Manzanita Creek;[21] another, Reflection, lies in a hollow of the extremely rough landslide surface.

Small lakes or ponds of another kind lie at the head of valley-side landslides where a hollow is formed because the downward movement of sliding mass is commonly faster and farther at its under than at its upper surface, so that its head is tilted backward, as near the left foreground of Fig. 13. The irregularity of the down-sliding is often shown by diversely tilted overthrown trees. Large slides sometimes involve a great, slab-like mass that stretches half a mile or more along a mountain side and nearly or quite as far down the mountain slope, as in the background of Fig. 13. In consequence of its somewhat irregular descent, the smooth forms of ordinary degradation are changed to curiously disorderly forms. At the head of these greater slides, many small, pond-holding hollows may be formed. Such ponds are short lived, but they may linger longer than the larger ponds that are held back on valley floors by the bulging front of slides, because such ponds are soon drained away by the valley stream.

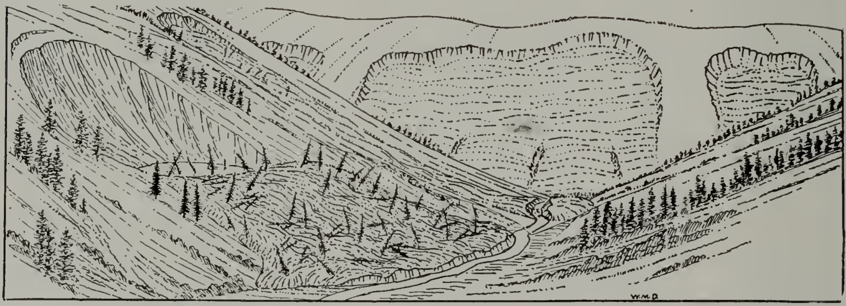

FIG. 13. Landslide diagram. In foreground, a recent slide with tilted trees; a small lake is held in the hollow back of it. A longer narrow slide is a short way beyond the nearer one. Three mountain-side slides are incompletely shown in the distance.

Landslides of this kind are numerous in those parts of the Coast Ranges where serpentine rock prevails, for that rock is prone to slip down from a mountain side after a valley is deeply eroded beneath it. Valley sides subject to sliding should evidently be avoided as far as possible by roads, pipe-lines, towers for electric power wires, and other structures for which stable foundations are desirable. The disorderly surface of slides may still be recognized years after any little ponds at their head have disappeared. However, a number of ponds still remain above the slides that abound on the slopes of Mustang Ridge, northeast of Peachtree Valley, which is in its turn northeast of the much larger Salinas Valley in the southern Coast Ranges.

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[21] A fine view of the lake is given in the frontispiece of Day and Allen's report on Lassen Peak, cited below.

According to a personal communication from Dr. J. H. Maxson of the California Institute of Technology, several landslide ponds occur in the serpentine areas of the Klamath Mountains in the northern part of the State.

Lakes of Glacial Origin

Glaciation of Californian Mountains

Most of the larger lakes named in the preceding sections lie on relatively low ground, presumably because they are associated with down-faulted areas or with down-sliding valley sides. The numerous lakes of the kind now to be described are found on mountainous highlands where their basins have been produced by the erosive action of great glaciers which covered considerable spaces in the higher parts of the Sierra Nevada and smaller spaces of other Californian mountains. That remarkable episode occurred in the Glacial period of recent geological time, a period of cooler and snowier climate on mountains that is believed to have been contemporaneous with the cooler and moister period when lakes were formed on interior desert lowlands.

In order to appreciate the importance of glaciation in respect to lake production, it should be understood that, in Preglacial time, there were in all probability no lakes on the Sierran highlands. The reason for this is that the highlands had then been long subjected to the ordinary erosional processes of weathering and streaming, which would have destroyed any lakes that might have been produced there in earlier times by faulting as described on foregoing pages, or by ancient volcanic action as will be described on following pages. Lake Tahoe is hardly an exception to this rule, for although produced by a combination of faulting and volcanic action, as will be told below, it is not on the highlands but occupies a deep trough below them.

The great Sierran glaciers of that time, the area of which has been mapped by Blackwelder,[22] had their sources in lofty valley heads where heavy snows were collected below the mountain summits and transformed into ice. The many separate glaciers that had their source in the high valley heads of each of the Sierran river systems united in broad sheets as they slowly advanced down the highlands of the western Sierran slope, but the sheets were irregularly interrupted by spurs and mounts that rose from the highlands to a greater height than the ice thickness. Then the sheets narrowed into faster moving ice tongues as they were drained down the previously eroded trunk valleys. While the descent was in progress the glaciers were melting to smaller and smaller volume as they reached lower and lower levels of warmer climate. By reason of the more extended area of their gathering grounds and of the larger number of their converging branches, the glaciers of the long western slope had greater size and pushed their ends down to lower levels than those on the shorter and steeper eastern slope of the mountains, which are diagrammed in Fig. 4. Thus the Tuolumne glacier, west of Mono Lake, extended for 34 miles along the crest of the range and ended 35 miles southwest of the crest; while for the San Joaquin glacier, south of that lake, the corresponding dimensions are 52 and 25 miles. On the steeper eastern slope, the measures along the crest and down the slope from it were much smaller.

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[22] Blackwelder, Eliot, Glacial and Associated Stream Deposits of the Sierra Nevada. Cal. State Div. Mines, Mining in California, July–October, 1932, pp. 303–310.

Two Epochs of Glaciation

Two terminal moraines are shown in each glaciated valley of Fig. 4. The lake that may have once occupied the earlier formed, outer basin has been filled by inwashed detritus and converted into a plain or meadow. The inner basin still holds a lake. Such is very commonly the case in the glacial troughs of the Sierra Nevada. It is inferred from this and from other evidence of a similar nature that there have been at least two epochs of glaciation. Critical studies of this kind in various parts of the world have indeed shown that the Glacial period was composite in the sense of including several alternations of colder Glacial epochs and milder Interglacial epochs. An excellent discussion of this problem for the Sierra Nevada is given by Blackwelder in his essay cited below; he there shows that, besides two later Glacial epochs, which he calls the Tahoe and the Tioga epochs, the work of which is illustrated in Fig. 4, there were two earlier Glacial epochs, the records of which are much modified and obscured by later erosion. The lakes produced in the latest or Tioga epoch are the chief subject of the following pages; but first the relation of the recent Tioga glaciers to the less recent Tahoe glaciers may be briefly stated.

There are four chief points to be considered. First, the Tahoe glaciers of the Sierra Nevada were longer than the Tioga glaciers and extended farther down their valleys, somewhat as shown by the moraines in the right half of Fig. 4. Thus while the largest Tioga glaciers ended at levels of about 6000 feet on the western and about 7000 feet on the steeper eastern slope of the mountains, the Tahoe glaciers ended perhaps 1000 feet lower. For example, in the Tahoe epoch the branch glaciers of Tenaya and Merced canyons joined to form the great trunk Yosemite glacier, which continued about 7 miles and ended at about the level of 4000 feet near the end of the great cliff-walled trough, the shape of which was largely produced by the intense glacial erosion of a pre-existing narrower and shallower valley, as Matthes has so well shown.[23] But in the Tioga epoch, the branch glaciers each ended in its own trough where lakes of the same names are now found, about 8 miles above the trough junction.

Second, the Tahoe moraines are many times larger than the Tioga moraines; some of the largest measure nearly 1300 feet in height. Third, by reason of their greater age, the cliffs of the Tahoe cirques are weathered to somewhat subdued forms, the cirque-floor basins are occupied by meadows, and their trough-end lakes are in nearly all cases now converted into detrital plains. Fourth, whatever lake basins the Tahoe glaciers produced at higher levels than the Tioga moraines are not now to be distinguished from the basins now occupied by the lakes of the Tioga epoch.

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[23] Matthes, F. E., Geologic History of the Yosemite Valley. U. S. Geol. Survey Prof. Paper 160, 1930.

The following pages, therefore, refer chiefly to lakes produced in the Sierra Nevada by the later Tioga glaciers, even if their work consisted largely in cleaning out detritus-filled rock basins of earlier Tahoe production. Some brief statements concerning extinct lakes of the Tahoe stage will be given at the close of this section.

All the Californian lakes of glacial origin are of relatively small size, but many of them are of great beauty; and as they are often closely associated with the superb scenery of the High Sierra they are greatly enjoyed by lovers of outdoor life when the hot summers of the lowlands prompt ascent to the cooler mountains. As the glacial lakes of the State far outnumber all others, much has been written about them. By far the best illustrations of these lakes, many of which are accessible only to mountaineers, are to be found in the annual volumes of the Bulletin issued by the Sierra Club of San Francisco, in which they are pictured in an incomparable series of photographs.[24] The loftiest glacial lakes occupy basins in cirque floors; these will be first described. Next will come those somewhat irregular lakes which lie at intermediate altitudes on trough floors or on the open Sierran highlands. Lowest are those which fill the terminal overdeepening of the enlarged valley-troughs, where they are partly enclosed by terminal moraines; these are most frequently visited.

Lakes in Glacial Cirques

Cirque lakes occupy shallow rock-basins in the floors of the great cliff-walled cavities excavated at the heads of glacial troughs, somewhat in the form of enormous quarries, 500 or 1000 feet deep and half a mile or a mile across. They abound in the High Sierra, where they are found below the loftier summits at altitudes of from 8000 to 10,000 feet. There and more strikingly in the northern and southern part of the range, where the mountains are not so high, cirque lakes were developed best on northeastern slopes, where snow drifting was favored of the westerly winds and where snow melting by sunshine was least effective. The peaks above such lakes are therefore unsymmetrical, being more rounded on the southwest slope and deeply cliffed on the northeast.[25] The cirques of the earlier Tahoe epoch, not reoccupied by the Tioga glaciers, are now, as above noted, weathered to somewhat dulled forms; their floors are cluttered over with talus from their walls and their lakes are converted meadows. Those occupied by the later and smaller Tioga glaciers are as bare as if recently abandoned by the ice.

Where several cirques are excavated opposite each other in the radiating valleys of a massive, dome-like mountain of Preglacial sculpture, the cirque lakes are separated from one another by high spurs, the upper parts of which are narrowed into saw-tooth pattern, while the central summit is reduced to a sharpened peak, as in Fig. 14; but where several Preglacial valleys, heading in a group of mountains, converge and join in a trunk valley, the cirque-headed troughs have a sim-

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[24] Among many others the following views are especially fine: Sierra Club Bulletin, vol. VII, Pls. 31, 40; vol. VIII, Pl. 6; vol. IX, Pls. 16, 20; vol. X, Pl. 226.

[25] Gilbert, G. K., Systematic Asymmetry of Crest Lines in the High Sierra of California. Jour. Geology, vol. 12, pp. 579–588, 1904.

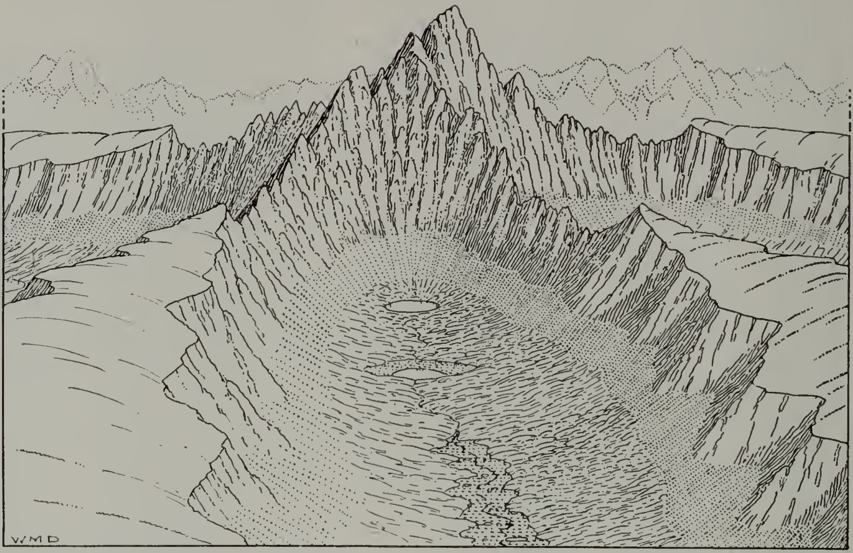

FIG. 14. A group of cirque-headed glacial troughs radiating from a lofty peak which has been sharpened by cirque recession on all sides. Small lakes or meadows are seen on the foreground trough floor.

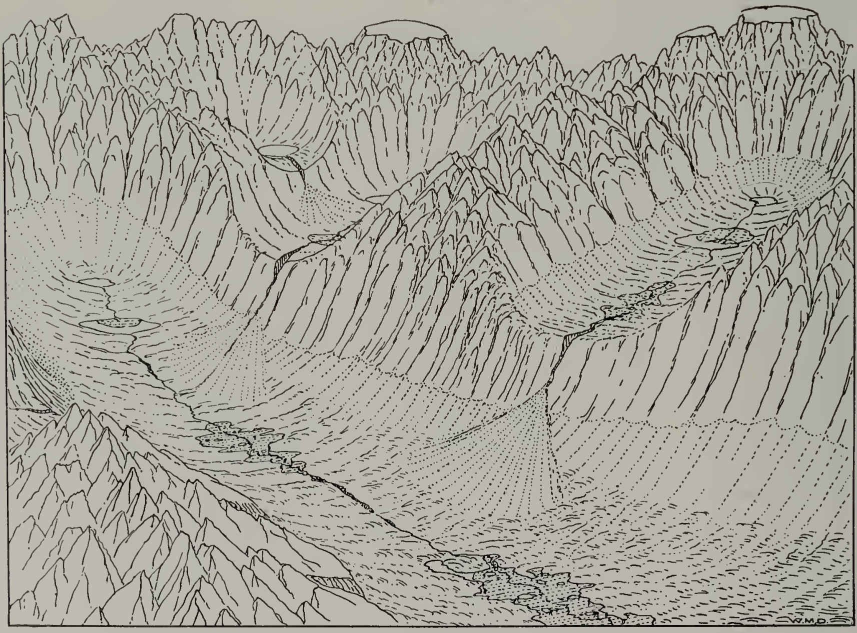

FIG. 15. A mountain group from which several converging, cirque-headed branch troughs all join the same trunk trough. The branch troughs "hang" over the trunk trough. Small lakes or meadows are seen on the trough floors.

ilar converging arrangement and the smaller ones 'hang' over the larger one, as in Fig. 15; here all the cirque lakes of such a group are rather closely associated. But it should be understood that vast as is the work of glacial sculpture in the High Sierra, the erosional work of ordinary weathering and streaming by which the mountains had been given their Preglacial form was vaster still.

It is in intimate association with these profoundly sculptured mountain forms that cirque lakes (Fig. 16) should be studied. If taken alone they cannot be appreciated, for their little basins are but a subordinate part of the great cirque-headed, cliff-walled troughs in which they are contained. The basins differ in no significant respect from the rest of the gigantic excavation, except that they are scoured to slightly greater depth so that they hold water. The same principle holds true, though perhaps less manifestly, in the study of all the other lakes of the State; it should be applied to the fault-basin and the landslide lakes already described and to the volcanic, river-made and other lakes to be detailed below. All are but items in the evolution of the landscape which they for a time adorn.

The Tehipite, Mt. Whitney and several other sheets of the U. S. Topographic Map show many striking examples of lakes in trough-head cirques excavated in the dome-like masses of the High Sierra. Regarding the concave cirque heads, W. D. Johnson, a skillful topographer, wrote in homely fashion: "These sharp outlines were suggestive of nothing so much as the scattered remnants of a sheet of dough on the biscuit board, after the biscuit tin has done its work."[26] A fuller discussion of these remarkable mountain forms is given by Lawson.[27]

Sometimes a series of small lakes, like beads spaced on a string, is seen occupying a succession of rock basins beginning in a cirque floor and continuing down stream from it. It is to be presumed that the convex rock sills between the basins were more resistant to glacial erosion than the basin rocks; the greater resistance may be due to the number and attitude of the joints in the rock quite as well as to variations in its composition.[28] Such series of lakes are to be seen at the headwaters of Iillilouette Creek, 16 miles southeast of the Yosemite Valley; also between Mammoth Mountain and Mammoth Crest, high up on the eastern slope of the Sierra, 22 miles south of Mono Lake; again, but more confusedly, farther south in the remarkable Sixty-lake Basin at the headwaters of Kings River under Mt. King, and still farther south under Mt. Genevra. Garnet Lake and Thousand-island lakes, about 9800 feet in altitude, are exceptional among cirque lakes in being beset with rocky islets; they are drained by a roundabout stream to the Middle Fork of San Joaquin River.

Cirque lakes become less abundant and disappear in the northern and far-southern Sierra Nevada where the altitude of the range decreases. Gold Lake, 2 miles long, on a head branch of the Middle Fork of Feather River, is one of the largest in the northern mountains.

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[26] Johnson, W. D., Grade Profiles in Alpine Crests. Jour. Geology, vol. 12, pp. 571–578, 1904; reprinted in Sierra Club Bulletin, vol. 5, pp. 271–278, 1905.

[27] Lawson, A. C., The Geomorphogeny of the Upper Kern Basin. Univ. Calif. Publ., Bull. Dept. Geol. Sci., vol. 3, pp. 291–376, 1904; see pp. 357–362. This article gives in Pl. 42 an excellent view of a fine cirque lake next southwest of Mt. Whitney, the highest summit of the Sierra Nevada.

[28] A striking view of a rock sill is given in Pl. 4 of Johnson's article above referred to.

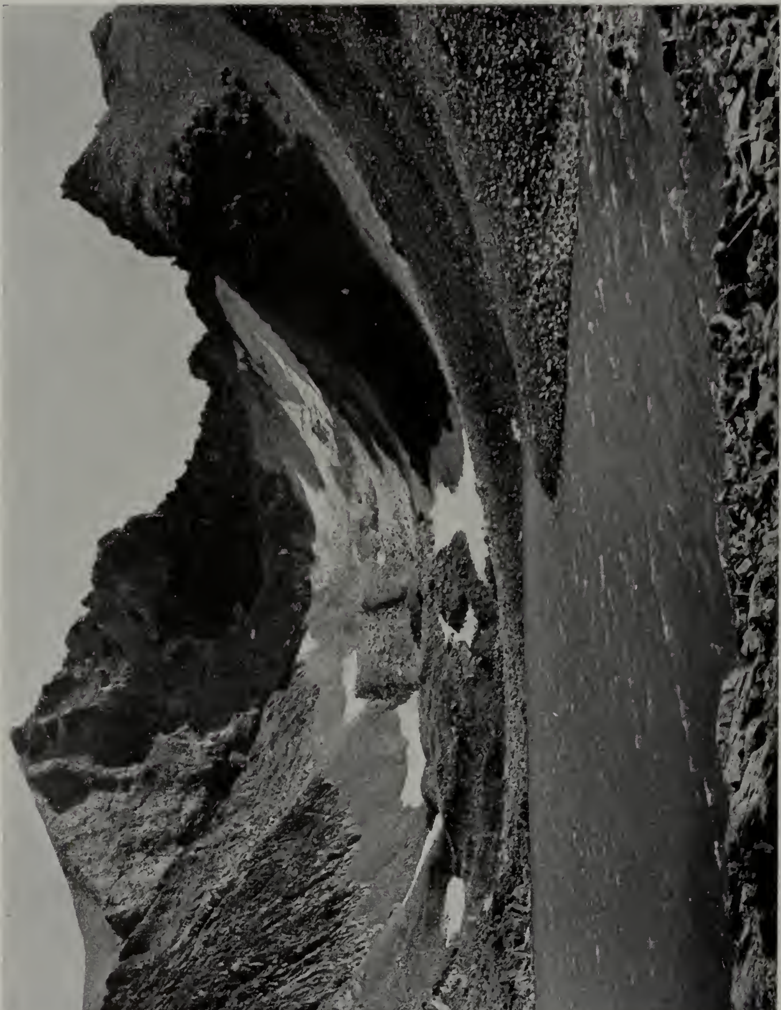

Photo by Ansel Easton Adams, Courtesy of Sierra Club.

FIG. 16. Typical glacial cirque and lake. Rodgers Peak from the north, Sierra Nevada.

Not so far north a group of cirque lakes is found under Sierra Buttes near the North Fork of Yuba River; one of them is figured by Turner.[29] Another northern group is found around Fall Creek Mountain, near the South Fork of the same river. Farther south, where the mountains gain altitude, cirque lakes are to be counted by the hundred, as may be seen on the Mt. Goddard sheet of the U. S. Topographic Map at the head of San Joaquin River, the Mt. Lyell sheet east of the Yosemite Valley, and the more southern Mt. Whitney sheet. In the far-southern part of the range, a number of small cirque lakes occur on the headwaters of Kaweah River in the Sequoia National Forest; fourteen such lakes, more or less converted into marshes, are clustered around the headwaters of the North Fork of Stanislaus River, as shown on the Big Trees topographic map.

Irregular Lakes on Trough Floors

Lakes of this kind lie on unevenly scoured trough floors, where some parts are a little deeper than others. They are of long-oval outline when they occur in narrow, steep-walled, well-smoothed troughs, but they are of very irregular outline and are often beset with low rocky islets and knobs of round-scoured rock when they occur in broadly open, flat-floored troughs. Their depth by no means indicates the depth of trough-floor excavation beneath the floor of a Preglacial valley, but only the excess of scouring of one part of the floor below another part. These irregular lake basins therefore correspond to the deeper parts of the bed of a stream channel eroded by running water. As their depth is usually small they are frequently replaced by inwashed stream detritus and thus converted into nearly level meadows, as in the foreground of Figs. 14 and 15.

Apparent examples are seen in the irregular Silver, Loon and Pleasant lakes, in branch troughs of the South Fork of American River. It may be here noted that, although glacially enlarged valley-troughs are commonly described as U-shaped in cross profile, they are, as a rule, much more like well opened, round-bottom Vs. It is only by way of exception, and in the Sierra Nevada only in the terminal troughs of Tahoe glaciation, that the U-shape is closely approached, as is shown by the rarity of cliff-walled valleys of the Yosemite type, among which Matthes has shown that Kings River, Hetch Hetchy and Tehipite troughs are to be included with the Yosemite masterpiece.[30]

Lakes on Ice-Scoured Sierran Highlands

The irregularly scattered lakes of the broad Sierran highlands lie in small and shallow rock basins. Where the country rock is granite, they are formed amid smoothly scoured and severely barren undulations of the surface; but on weaker rocks, where forests alternate with grassy glades, they are associated with a more pleasingly picturesque scenery. One should here, in order to appreciate the transformation of the landscape that ice-scouring has accomplished in the glaciated areas, recall what was said above as to the absence of highland lakes in Preglacial time, and to that may be added Lawson's description of

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[29] Turner, H. W., U. S. Geol. Survey Geol. Atlas, Downieville folio (No. 37), Fig. 3, 1897.

[30] Matthes, F. E., *op. cit.*

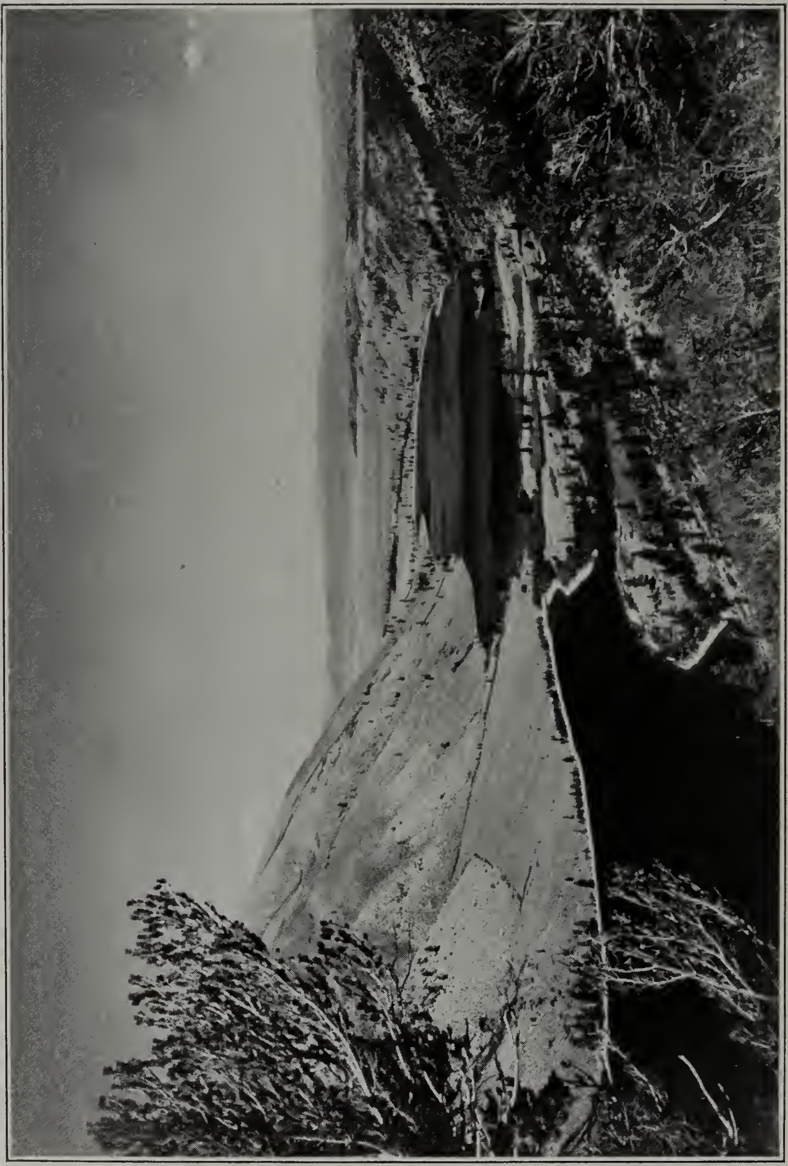

Photo by Eliot Blackwelder, Courtesy of Geological Society of America, Fig. 10, vol. 42, no. 4.

FIG. 17. Twin Lakes, Sierra Nevada.

a non-glaciated southern area of the mountains. That experienced observer wrote: ''A remarkable feature of the upland surfaces is the prevailing absence of water courses or incisions of any kind due to stream cutting. * * * The surface is everywhere encumbered by blocks of granite, formed by the intersection of joints and dislodged by the heaving action of frost. The veneer of loose blocks is so thick that the waters from summer rains and from melting snows do not gather in runways and so establish lines of stream cutting, but flow in a diffused fashion between and beneath the blocks. * * * It is only when we get to the bottom of the canyons and cirques that the granite is tight enough to hold water on its surface. It would thus appear that these upland surfaces are as free from the attack of running water as are the driest deserts.''[31]

It may be said further that the highland veneer of granite blocks has probably been continued from an early time before the upheaval of the mountain mass, when it was part of an extensive and soil-covered lowland of long-continued degradation, which in its southern area at least probably had a desert climate; for on such a lowland the well disintegrated soil at the surface must have been underlaid by less disintegrated joint blocks to a certain depth below the surface. Not that all the joint blocks on the non-glaciated highlands of today were then prepared, but that the present blocks there are the direct successors of their ancient predecessors. A veneer of similar blocks probably overspread all the highlands in Preglacial times, but in the areas that became glaciated they were swept away down to firm rock, as the following quotations show.

Lindgren has described the more barren highlands as ''vast stretches of dazzling white granitic rock surface, worn and rounded''; and he adds concerning a climax area: ''There are few more imposing sights than the ice-swept rock deserts of the * * * Devil's Basin,''[32] a wide area at an altitude of 8200 feet, dotted with little lakes or with grassy flats at the head of the South Fork of American River, 7 miles southwest of Lake Tahoe. Humphrey Basin is a similar area, over 11,000 feet in altitude, at the head of the South Fork of San Joaquin River; it is included on the Mt. Goddard map sheet, which shows the well-named Desolation Lake, a mile in length. The depth of these highland lakes is not a true measure of glacial erosion that the highlands have suffered; it measures only the excess of erosion in the lake basin below that on the neighboring surface.

Blackwelder remarks that the ancient glaciers left on the scoured highlands ''vast areas of comparatively bare granite, upon which so little forest grows that the rocks stand out gray and white.''[33] The monotony of these rock deserts is here and there relieved by tree-covered patches of glacial detritus; also by perched boulders, left there when the ice cover melted away. The undulating and polished granite surface, more or less scaled off, and the perched boulders are well illustrated in Matthes' report (Pls. 35B, 36, 37B), referred to above.

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[31] Lawson, A. C., *op. cit.*, pp. 313, 314.

[32] Lindgren, Waldemar, U. S. Geol. Survey Geol. Atlas, Pyramid Peak folio (No. 31), 1896.

[33] Blackwelder, Eliot, Pleistocene Glaciation in the Sierra Nevada. Geol. Soc. America Bull., vol. 42, pp. 865–922, 1931. This paper contains several excellent views: Fig. 1, a lateral glacial trough hanging high over a main trough; Fig. 2, talus in a glacial trough; Fig. 3, glacially polished granite with perched boulders; Fig. 10, a divided trough lake, here reproduced in Fig. 17; Fig. 15, a meadow replacing a glacial lake.

The lakes on the scoured highlands are not infrequently rimmed with low walls or 'ramparts' of boulders and stones, which have been, according to Gilbert,[34] gradually pushed out from the shallow bottom in the milder spells of winter weather, when the ice expands a little after having contracted during preceding spells of severe cold. When its temperature falls 7° Fahrenheit, the ice of a frozen lake a mile across will contract a foot. Cracks are then opened through the ice; but they are soon closed by new-formed ice. A warm spell then expands the ice and it spreads a little on the shores. A repetition of this through many winters has resulted in shoving outward all boulders that the shore ice rests upon, and thus in time a rampart is formed.

Trough-End Lakes

Lakes lying at the end of an over-deepened valley-trough of the Tioga epoch, where their retention is aided by a loop of morainic ridges, are nearly always of simple, long-oval outline and of a considerable depth, some being as deep as 200 or 300 feet; but their original length is somewhat decreased by the inwashed delta of the trough stream. Thus Merced Lake, in a trough-end basin of the Tioga epoch drained by Merced River to the Yosemite Valley, is now partly filled by a forested delta, well shown in Plate 12B of Matthes' report. Blackwelder notes that near these lakes, "acres of polished and grooved rock are a familiar sight"; also that the rock polish is here better preserved than on similar surfaces scoured by the earlier Tahoe glaciers.

The oftenest seen lake of this important class is Donner Lake, which lies next north of and well below the line of the Southern Pacific Railroad where it descends the eastern slope of the Sierra Nevada from Donner Pass to Truckee Valley. It is 3 miles long and is enclosed by heavy morainic ridges, in great part of Tahoe age, at an altitude of 6095 feet. Another terminal lake in the same drainage basin, but less often seen, as it lies higher in the mountains to the northwest, is Independence, about 2 miles long at an altitude of nearly 7000 feet. The southern or main upper course of Truckee River, which drains Lake Tahoe, leads to several well known terminal lakes: Fallen Leaf Lake is a popular summer resort on the southwest side of Lake Tahoe; it is of about the same length as Donner, but has an altitude of nearly 6400 feet. The Tioga terminal moraine, close around the foot of the lake, is of small size; the Tahoe moraines, enclosing the Tioga moraine, are vastly larger; one on the southeast of the lake is over 3 miles long and rises 900 feet like a great railroad embankment. The glacial origin of this beautiful lake was recognized by Le Conte 60 years ago; but in stating that the basin of Lake Tahoe also had been filled by ice he showed an exaggerated idea of the dimensions of the ancient glaciers.[35]

A recent and well illustrated essay by Jones on this picturesque district limits the glaciers to more moderate lengths.[36] Cascade Lake, 3 miles northwest of Fallen Leaf and of similar size and altitude, is pictured as seen from above in a compound loop of morainic ridges. A mile farther north is Emerald Bay, like the other two lakes except that it lies at the level of Tahoe, with which it is connected through a frontal opening in its 600-foot moraines. Echo Lake, a mile long, 3 miles south of Fallen Leaf, belongs in a somewhat different class, as it lies at an altitude of 7500 feet just back of the lip of its lateral trough, which hangs 500 feet above the floor of the main and much larger trough of the Upper Truckee glacier. This lake is peculiar in having its waters artificially diverted from Truckee River and led southward through a tunnel to a head branch of the South Fork of the west-flowing American River, to increase the volume of that Fork for electric power. Other examples of trough-end lakes are Emigrant, Huckleberry and Tilden, each about 2 miles long and all in steep-sided branch troughs of the North Branch of Tuolumne River.

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[34] Gilbert, G. K., Lake Ramparts. Sierra Club Bulletin, vol. 6, pp. 225–234, 1908.

[35] Le Conte, Joseph, On Some Ancient Glaciers of the Sierra. Am. Jour. Sci., 3d ser., vol. 10, pp. 126–139, 1875.

[36] Jones, Wellington, Glacial Land Forms in the Sierra Nevada South of Lake Tahoe. Univ. Calif. Publ., Geogr., vol. 3, pp. 135–157, 1929.

A peculiar group of glacial lakes, well illustrated on the topographic map of the Yosemite National Park, 1932, is found in the semicircular glacial trough which is drained by the well-named Reversed Creek back of Reversed Peak, about 12 miles south of Mono Lake. The creek heads in June Lake, which is apparently held by a terminal moraine at the northern end of the eastern arm of the semicircle; it then flows south through Gull Lake and, curving to the west, enters Silver Lake, from which it flows north along the western arm of the semicircle and thus, a few miles farther north, reaches Grant Lake, held by another terminal moraine, through a gap in which the outlet, there known as Rush Creek, continues to Mono Lake, about 7 miles distant.

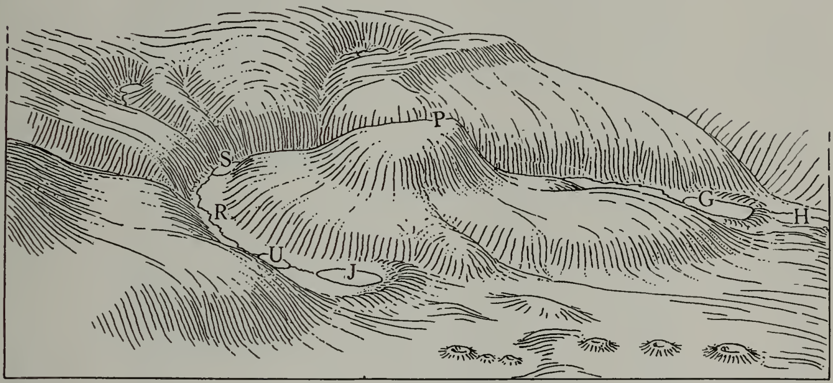

FIG. 18. Sketch of relief south of Mono Lake, looking southwest; June Lake (J); Gull Lake (U); Reversed Creek (R); Silver Lake (S); Reversed Peak (P); Grant Lake (G); and Rush Creek (H).

Twin Lakes, 3 miles in combined length, stand at altitudes of 7076 and 7096 feet on a fork of Walker River, 15 miles southwest of Mono Lake. They result from the subdivision of a single, trough-end lake by inwashed detrital fans near its mid-length, as explained and illustrated by Blackwelder, whose fine photograph of them is here reproduced in Fig. 17. These lakes are shown with many others on the Bridgeport topographic map. The most famous double lake of this kind is in Switzerland, where an originally single lake, occupying the long and greatly overdeepened valley trough of the River Aar, has been divided into Lakes Brienz and Thun by the combined deltas of two opposite side-streams; the beautiful town of Interlaken stands on the fans; and the outlet of Lake Brienz winds between the fans to Lake Thun.

A group of tarns, known as the Volcanic Lakes, occupy the floor of the large, cirque-like trough head of Dougherty Creek, a south branch of the Middle Fork of Kings River; they are believed to be not of volcanic but of glacial origin and are said to have taken their name from some volcanic rock near by.

Extinct Glacial Lakes in the Sierra Nevada

It has been noted above that the trough-floor and terminal lakes of the long Tahoe glacial troughs are now as a whole converted into treeless meadows or forested valley floors of inwashed detritus, the meadows being attractive features of the Sierran highlands. Such meadows and plains are longer than the lakes which they replace, because their gently slanting surface extends farther up the valley-trough floor than the level surface of the lake could reach.

The best known example of this kind occupies the great cliff-walled glacial trough of the Yosemite Valley, of which Matthes has given an admirable description, above cited. The lake which originally filled the gouged-out terminal rock basin of the trough and which was partly held back by the terminal moraine of its 20-mile Tahoe glacier, is estimated to have had a length of 5½ miles, and it was therefore one of the largest of its class. There is little question that the marvelous scenery of the Valley would be more marvelous still if the lake had not been destroyed. Another detrital plain occupies the lower part of Tenaya Canyon, the eastward extension of the Yosemite. Mirror Lake (see Matthes' Plate 47a), a small pool on that plain, is not a remnant of the rock-basin lake that the plain replaces, for that lake has been completely filled; the little lake is due, again according to Matthes, to the active, avalanche-like downfall of rock blocks from the oversteepened cliffs, by which the stream that formed the plain has recently been slightly obstructed. One of the longest aggraded troughs in the Sierras is found in the Tuolumne Meadows; it probably conceals several trough-floor rock-basins.

Non-Sierran Glacial Lakes

The only glacial lakes in the mountains of southern California are two small ones, Dollar and Dry, in cirques below Mt. San Gorgonio, the dominating dome-like summit, 11,485 feet in altitude, of the San Bernardino Mountains.[37] The mountains in the northern part of the State contain a considerable number of glacial lakes, all of small size. Curiously enough, Lassen Volcanic National Park, between the Sierra Nevada and Mount Shasta, contains according to Williams[38] many more glacial than volcanic lakes. The park district pretty surely possessed a good number of lava-barred lakes during a former time of greater volcanic activity; but the lakes then produced have been converted into plains and some of the lakes found there today appear to result from the excavation of these filled basins by ice action. To the south and east of Lassen Peak, Helen, Emerald, Shadow and Cliff lakes, each only a quarter-mile or less in diameter, occupy basins wholly the product of glacial erosion. Farther east Rainbow, Twin, Swan and the six Cluster lakes have been similarly produced. The same may be said of a score of little wet-weather ponds on the lava flow of Crater Butte, east of the park center. Horseshoe Lake, nearly a mile across, and Juniper Lake, about 1 by 2 miles, in the southeastern part of the park, occupy intervolcanic depressions modified by glacial action.

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[37] Fairbanks, H. W., and Carey, E. P., Glaciation in the San Bernardino Mountains, California. Science, vol. 31, pp. 32–33, 1910.

[38] Williams, Howel, Geology of the Lassen Volcanic National Park, California. Univ. Calif. Publ., Bull. Dept. Geol. Sci. vol. 21, pp. 191–385, 1932.

Farther northwest, a good number of small cirque lakes occur in the Klamath Mountains at altitudes of from 6500 to 7500 feet.[40] A small lake of this kind in the neighboring Siskiyou Mountains is shown in Fig. 19 and a small meadow-marsh resulting from the filling of such a lake is shown in Fig. 20.

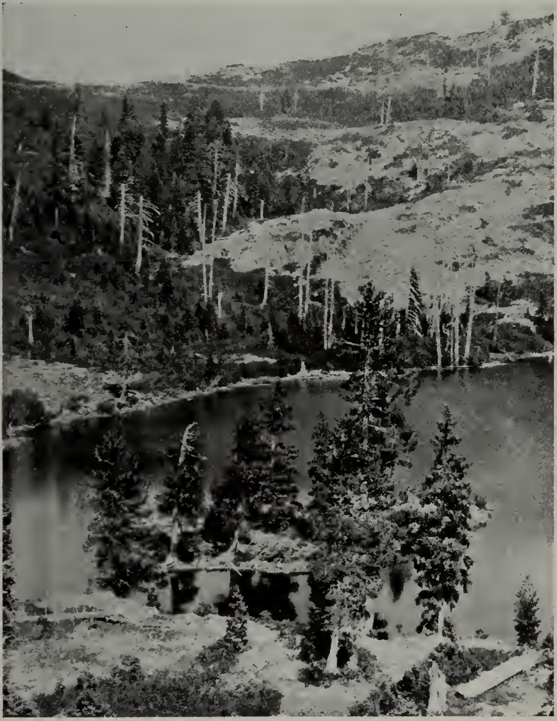

Photo by J. H. Maxson.

FIG. 19. Island Lake, Siskiyou Mountains.

Lakes in Basins of Limestone Solution

Limestone is a relatively soluble rock: some of its underground fractures or "joints" are commonly more or less enlarged into passages or caverns by the solution of their walls in ground-water. Such enlargement commonly begins along the intersection of two joints; and as it progresses surface streams frequently disappear by descending at "sinks" into the underground passages. If such an underground passage is obstructed, a pond or lake may be formed over the sink. It has been suggested by Baker[41] that Bear Lake, which had a length of about a mile in a flat-floored valley at an altitude of about 6700 feet in the San Bernardino Range, is of this origin. A dam at the lake outlet now holds back a reservoir 5 miles long when filled to capacity.

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[40] Hershey, O. H., Ancient Alpine Glaciers of the Sierra Costa Mountains in California. Jour. Geol. vol. 8, pp. 42–57, 1900. See the Sawyers Bar and Seiad sheets of the U. S. Topographic Map.

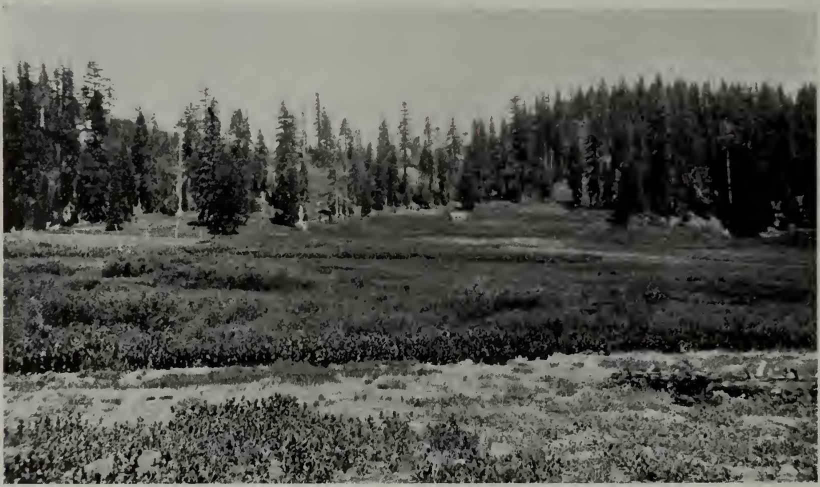

Photo by J. H. Maxson.

FIG. 20. A marshy meadow replacing a small glacial lake, Siskiyou Mountains.

In certain limestone districts lakes are formed by the obstruction of rivers where calcareous tufa is deposited in river channels, apparently where springs charged with limestones in solution emerge from the channel bed. No lakes of this kind have been reported in California.

Lakes of Volcanic Origin

Several lakes of volcanic origin occur in Lassen Volcanic National Park in the northern part of the State, but the lakes there are mostly of glacial origin, as already told. They are all well shown on the topographic map of the park (1929). Two of the best known are Butte (formerly Bidwell) and Snag lakes, each about a mile long and at an altitude of about 6500 feet: they were first described by Diller[42], but the following details are taken from a later and fuller account by Williams.[43] He explains that the valley of a north-flowing stream was obstructed by a lava flow in preglacial time, as in the upper right corner of Fig. 21, and a lake several miles in length was formed upstream from the obstruction. The basin was, however, much modified by a glacier which for a time crept along the valley floor, although it did not succeed in wholly removing the lava barrier. After the glacier disappeared a lake occupying the modified basin was more or less filled with marshy deposits. Then a small volcano, known as

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[41] Baker, C. L., Mohave Desert Region in southern California. Univ. Calif. Publ., Bull. Dept. Geol. Sci., vol. 6, pp. 333–383, 1911. See p. 364, Pls. 41, A and B.

[42] Diller, J. S., A Late Volcanic Eruption in Northern California. U. S. Geol. Survey Bull. 79, 1891.

[43] Williams, Howel, *Op. cit.*

Cinder Cone, was built up on the western side of the valley and a ragged lava stream that was extruded from its base spread over a medial part of the original lake basin, as in the middle of Fig 21, thus producing Snag Lake.

The small Hat Lake, at the northeast base of Lassen Peak, is the youngest lake in the park, as it was formed in consequence of the obstruction of the headwaters of Hat Creek by a mudflow from the peak during the eruption of 1915.

Lakes not infrequently occur in the craters of recently extinct volcanoes. Thus a small lake occupies the summit cavity of Crater Butte, east of Lassen Peak. A little wet-weather lake of the same kind occupies the crater of an unnamed cone about 20 miles farther east; a tiny lake is mapped at an altitude of 12,000 feet in the crater of Shastina, a secondary volcano on the west slope of Shasta; and two minute lakes are found in the craters of small cones on Paoha Island in Mono Lake.[44]

Medicine Lake in northeastern California stands near the center of the Modoc lava field which has been mentioned above in the account of several fault-basin lakes at the northern boundary of the State; and this lake like those has been described by Peacock,[45] in brief as follows: A broad and low dome of lava was built up by local eruptions of fluid lavas on the larger field; and the dome was crowned by an imperfect ring of later cones, of which Mt. Hoffman is one, most of them made of cinders; their brown or reddish color is more or less concealed by a forest cover. The highest member of the ring, Big Glass Mountain, about 8000 feet in altitude, composed of dark obsidian or volcanic glass, which appears to have been viscous when erupted and which therefore accumulated in a huge pile instead of spreading out in nearly level flows. The ring includes also several smaller cones of pumice or frothy lava, white and barren. Some of these eruptions are of extremely recent date; one of the lava flows, when just at the limit of its advance, pushed and charred a tree trunk that is still standing at the lava edge.

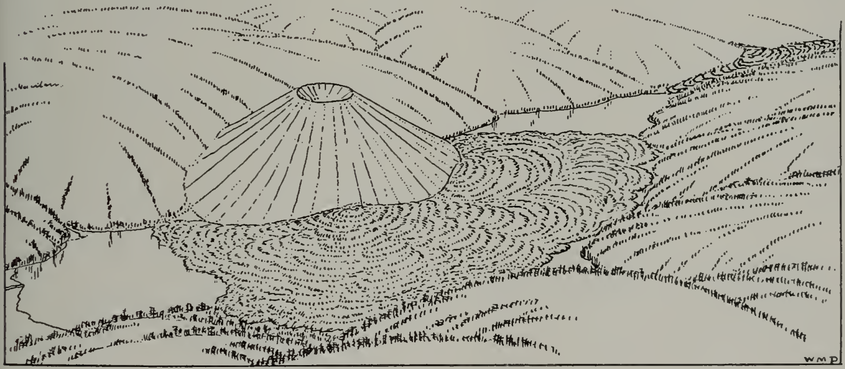

FIG. 21. Diagram of volcanic lakes.

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[44] Russell, I. C., Quaternary History of Mono Valley, California. U. S. Geol. Survey Eighth Ann. Rept., pt. 1, pp. 261–394, 1889. See pp. 373.

[45] Peacock, M. A., The Modoc Lava Field, Northern California. Geog. Rev., vol. 21, pp. 259–275, 1931

Within the ring of cones a hollow space remains less filled up, and in its lowest part lies Medicine Lake, about 2 miles long at an altitude of 6500 feet. It is clear and fresh although it has no overflowing outlet.

Similar to but much smaller than Medicine Lake is Thurston Lake, which occupies a deep hollow that is accidentally enclosed by the up-building of several volcanic mounts around it in the volcanic district which adjoins Clear Lake, above described, on the south. The water surface in these two lakes is said to stand at the same level and to vary equally with change of seasons, as if a connection between the lakes were maintained by underground percolation. Several similar hollows among these volcanic mounts are now occupied by detrital plains.

Ancient Volcanic Lakes

A number of lava-barred lakes of earlier origin in the Lassen Peak region have been converted into meadows. For example, about 20 miles southeast of the peak, an ancient lava flow ran into and formed a dam across the valley of the North Fork of Feather River, and the river thereupon rose in a lake; but what with inwash of detritus and erosion of an outlet gorge through the dam, the lake has disappeared. Its bed is known as Big Meadows, 15 miles in length,[46] now in part flooded in a reservoir as told below. Similar features are found around Mt. Shasta; the largest plain, known as Shasta Meadows and measuring 20 by 10 miles, lies 20 miles northwest of the great volcano at an altitude of 2750 feet. It is probable that several similar meadow plains would be found near Lassen Peak, were it not that their unconsolidated detritus has been removed by glacial scouring. Juniper and Horseshoe lakes, already described in the section on lakes of glacial origin as occupying inter-volcanic depressions modified by glacial erosion, deserve mention here also, because in preglacial time they were probably represented by detrital plains.

In his account of Mono Lake, I. C. Russell made brief mention of a former lava-barred lake, now represented by a small playa basin; it lies about 30 miles northeast of Mono. A well defined but extinct lake of the same origin in Truckee Valley is now, according to Lindgren,[47] represented by Martis Valley, a plain of fine sediments 4 miles across at an altitude of 5900 feet, next east of the town of Truckee. The lake rose to an altitude of 6000 feet in consequence of a lava barrier that blocked Truckee River not far to the east. The river has now not only washed a quantity of sediment into the basin but has drained away the lake by cutting down a gorge through the barrier; since then it has trenched a shallow valley along the northern border of the lake-basin plain.

A larger example of a plain that replaces a volcanic lake occupies Mohawk Valley in the northern Sierra Nevada. The original depression is believed to have been a down-faulted trough, drained westward by the Middle Fork of Feather River, and therefore resembling the two similar fault-troughs farther northeast, drained by the North fork, as above described under fault-basin lakes. According to Turner[48] the Mohawk trough was blocked on the northwest by a heavy body of lava; the lake thereupon rose to a level of 5100 feet, thus gaining a length of 11 miles and a width of 2 or 3, with a northeast arm 7 miles long. Although now drained by a gorge cut through the lava barrier, the lake-shore terraces, more or less dissected by local brooks and the bottom deposits at levels of from 4400 to 4600 feet memorialize the vanished lake. Not far south is the larger intermont basin plain of Sierra Valley of similar origin; it will be described in the next section with Lake Tahoe.

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[46] This ancient lake is mapped in Plate 47 of J. S. Driller's report on the Geology of the Lassen Peak District. U. S. Geol. Survey Eighth Ann. Rept., pt. 1, pp. 395–432, 1889.

[47] Lindgren, Waldemar, U. S. Geol. Survey Geol. Atlas, Truckee folio (No. 39), 1897.

Two small examples of extinct, lava-barred lakes are known near the above-described Clear Lake of the northern Coast Ranges. One lies between the two eastern arms of the lake in a mountain cove, the eastward opening of which has been blocked by a small lava sheet. The resulting basin, measuring a mile or more in length, is mostly occupied by a plain, but its western part is overspread after winter rains by the shallow Borax Lake, which vanishes in summer leaving a barren, white flat. A larger basin plain, measuring 1 by 4 miles, lies in an upland valley north of the lake arms; the valley outlet is reported to be blocked by a lava flow: this secluded plain presents an attractive, park-like appearance by reason of the scattered oaks that flourish on its level fields.

An extinct lake in the southern Sierra Nevada, now represented by several miles of meadows at an altitude of 8200 feet, is drained by Golden Trout Creek, which cascades down a gorge that it has cut in an obstructing lava flow in its westward descent to the canyon of the Upper Kern River. The lava flow came from a near-by cone of small size.[49]

Hot-Spring Lakes

In striking contrast to an above-described lake, the basin of which results from the solution of limestone rock in descending surface waters, are certain small lakes of Lassen Volcanic National Park. They result from the solvent action of ascending hot-spring waters which, coming from an underground source where high volcanic temperatures still prevail, rise through the lavas of extinct volcanoes, disintegrate them, carry away their more soluble minerals, and leave an insoluble residue of sticky kaolin mud on the shallow floor of the resulting cavity.

The largest and best known of these is the famous Boiling Springs Lake—Lake Tartarus of the earlier maps—which is situated at an elevation of 5750 feet in a cavity on the northeast slope of Red Mountain, near the middle of the southern border of the park. According to Day and Allen,[50] it is 220 yards across when filled to overflowing. Its shore is then marked by a chain of steaming springs and bubbling mud-pots. At times of lower water, it is more quiet. The group of hot-spring pools known as Bumpus Hell of similar origin, at an altitude of 8000 feet in a crater-shaped cavity 500 by 1400 feet across, 2 miles south of Lassen Peak, is remarkable for its boiling fountains and sulphurous

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[48] Turner, H. W., U. S. Geol. Survey Geol. Atlas, Downieville folio (No. 37), 1897.

[49] Lawson, A. C., The Geomorphogeny of the Upper Kern Basin. Univ. Calif. Publ., Bull. Dept. Geol. Sci., vol. 3, pp. 291–376, 1904. See p. 320, pls. 31, 35, 36.

[50] Day, A. T., and Allen, E. T., The Volcanic Activity and Hot Springs of Lassen Peak. Carnegie Inst. Washington Publ. 360, 1925. See pls. 8, 9; Fig. 44.

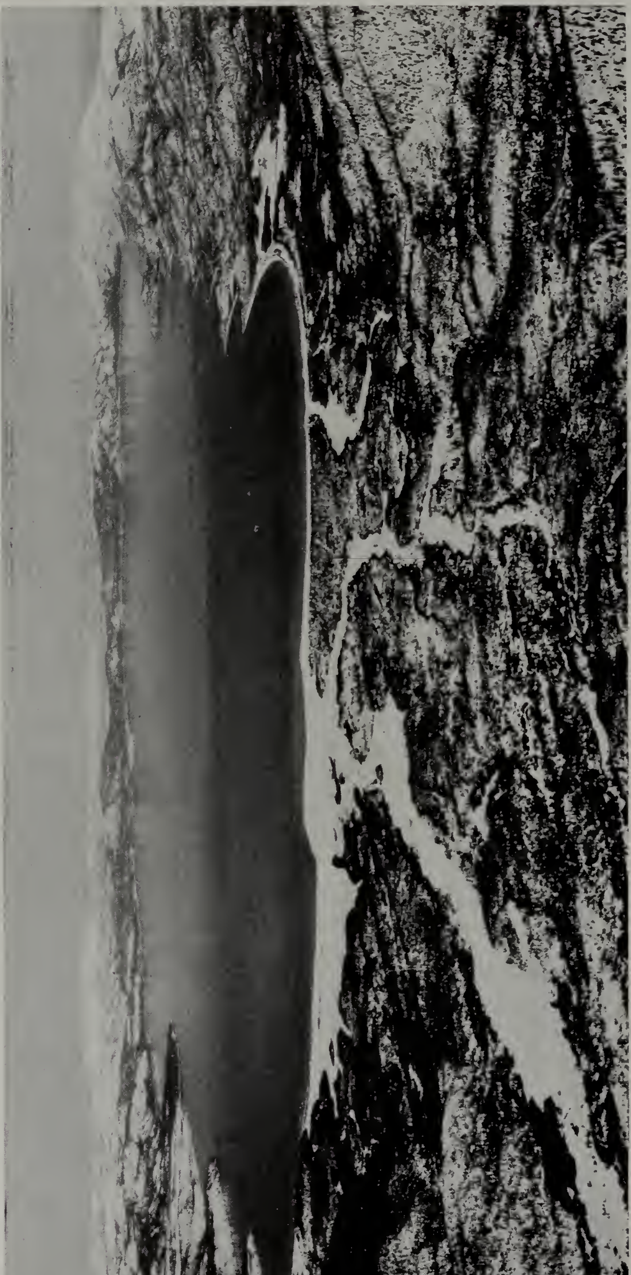

Fig. 22. Air-view of Lake Tahoe.

odors. The steam issuing from one of its roaring fumaroles had a temperature of 250° C. in 1916. The temperature of its pools was 86° C., which is the boiling point of water at that altitude.

The water of hot volcanic springs is explained by some geologists as wholly derived from the steam liberated from molten rock or 'magma', during its ascent from deep subterranean sources; it is therefore called 'juvenile' water, because it is believed never to have reached the earth's surface before. Detailed analyses of the Lassen Peak hot springs have led the above-named authors to reject this view; they regard the water of those springs as chiefly supplied, like ordinary springs, by local rainfall, and explain its high temperature by the addition of a relatively small amount of steam released from underground magmas.

Lake Tahoe and Sierra Valley

Lake Tahoe, the most famous of Californian lakes but partly included in the western angle of Nevada, deserves a section for itself (Fig. 22). It measures 21 by 12 miles, stands at an altitude of 6225 feet, and has the altogether exceptional depth of 1645 feet. Its origin is composite, as explained by Lindgren[51] and Reid.[52] It is held by a volcanic barrier in the southern part of a great, down-faulted trough, 70 or 80 miles in length, northwest-southeast, which in association with the faults of the more northern part of the Sierra Nevada described by Diller, as told above, separates some outstanding mountain blocks from the main mass of the Sierra Nevada along the northern third of its eastern border. A main scarp of the range, which here forms the western side of the Tahoe basin, may be traced more or less continuously for 120 miles northwestward. Tahoe is thus related to lakes in little filled intermont troughs, as well as to volcanic lakes.

The barrier which shuts off the basin of Tahoe from the rest of its long trough is a somewhat ancient and much dissected volcano, known as Mount Pluto, 8700 feet in summit altitude. Lindgren explains that when this great barrier was first formed, the lake rose several hundred feet higher than now. Its outlet, Truckee River, then ran northward between the western slope of the volcano and the main eastern scarp of the Sierra Nevada. The lake level was slowly lowered as the outlet cut a gorge through the lava barrier. A second rise of lake level was caused by a later lava flow which blocked the first-cut gorge, thus making the lake doubly of volcanic origin; then a second gorge was eroded and the lake was again lowered. According to Blackwelder,[53] glaciers from the west entered Truckee Canyon and built large moraines in it as much as 200 feet above the present lake level; thus obstructing the outlet for a third time and making it partly of glacial origin. Fallen Leaf and other lakes, held back by moraines on the southwestern side of Tahoe, have been mentioned above.

Lake Tahoe is probably best known outside of California from having been mentioned in "Roughing It" by the American humorist, Mark Twain, who wrote amusingly of the transparency of its waters, in which he "could see trout by the thousands winging about in the emptiness" at a depth of 80 feet. Because of its mild summer climate and of its picturesque surroundings, its shores have become a popular summer resort. A general account of the scenery of the lake in connection with its complex origin has been prepared by Louderback.[54]

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[51] Lindgren, Waldemar, The Tertiary Gravels of the Sierra Nevada of California. U. S. Geol. Survey Prof. Paper 73, 1911. See pl. 1.

[52] Reid, J. A., The Geomorphogeny of the Sierra Nevada northeast of Lake Tahoe. Univ. Calif. Publ., Bull. Dept. Geol. Sci., vol. 6, pp. 89–161, 1911.

[53] Personal letter, dated July 6, 1932.

The northern part of the long, down-faulted trough was also cut off from the middle part by volcanic eruptions and there an extensive basin plain, known as Sierra Valley, measuring 19 by 15 miles at an altitude of from 4800 to 4900 feet, has been filled in with heavy detrital deposits. Like the above mentioned Indian and American valleys, not far to the northwest, this basin plain, which is today marshy in its western part, may have been at various times in its growth overspread by a shallow lake; but today it is drained nearly dry by the successful erosion of the deep gorges of Feather River through the mountains on the west.

The basins of Lake Tahoe and of Sierra Valley thus appear to be of similar origin, but they present certain contrasts. Lake Tahoe at an altitude of 6225 feet is drained to the east through a short gorge cut in its lava barrier; Sierra Valley at an altitude of about 4800 feet is drained to the west through a long canyon cut nearly all across the Sierran range. Lake Tahoe consists of a high-standing body of in-drained water, while Sierra Valley consists of a lower-standing body of in-washed detritus. The reason for the second contrast is probably to be found in part in the second lava flow on the flanks of Mount Pluto, by which Lake Tahoe was raised above the level of most of the in-filling detritus that had accumulated in the earlier formed lake; but it is probably because of the first lava flow that the much greater altitude of the Tahoe water-surface than of the Sierra Valley plain is due.

River-Made Lakes

Oxbow Lakes

Various kinds of lakes or sloughs are associated with California's larger rivers. Oxbow lakes, representing cut-off river meanders in various stages of extinction, as illustrated in Fig. 6, occur along the Sacramento with radius of quarter or half a mile, and less frequently and of smaller size along the San Joaquin. Pear Slough, near this river, is an excellent example; its name is perhaps taken from its pear-like outline. Here may be mentioned Murphy Lake, occupying a curved and narrow channel 3 miles long, northeast of the junction of Feather River with the Sacramento; also McGriff, Mary, and Horseshoe lakes, apparently of similar origin, which lie east of the Sacramento farther north.

Flood-plain Marshes

Extensive reed marshes or tulares, known as 'basins,' occur on the less aggraded lateral parts of the flood plain of the lower Sacramento River, as illustrated in Fig. 6. They may be given the appearance of large lakes when the river overflows after winter rains. Thus Sutter Basin, 10 by 2 or 3 miles, lies to the east of the river, and Yolo Basin or Slough, 20 by 4 miles, lies to the west; its less aggraded part includes a more permanent sheet of water known as Big Lake, 1½ miles in diameter. The extensive reed growth in these basins is disadvantageous in a region of moderate rainfall where the conservation of water supply becomes important, for the loss of water by evaporation from the growing reeds is many times greater than from a free water surface.[55] A similarly disadvantageous loss is suffered by the Nile where it flows through an extensive papyrus marsh many miles south of its flood plain in Egypt.

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[54] Louderback, G. D., Lake Tahoe, California-Nevada. Jour. Geography, pp 277–279, 1911.

Side-stream Lakes

The shallow valleys of small tributary streams are not infrequently laked back of the alluvial up-building of the flood plains of their trunk rivers, as in the upper right part of Fig. 6; and the backed-up lake water then invades the branches of the tributary valley just as the sea invades branching valleys on a subsiding coast and transforms them into branching bays. Such appears to be the origin of Stone Lake, with 4-mile branches, to the east of the lower Sacramento; and of Cache Slough in the extensive marshes of the Yolo Basin; and of the branched Lindsey Lake, west of the river. Also of Plumas Lake, 3 miles long backed up by Feather River flood plain; of Tracy Lake, 2 miles long with several branches, and Sycamore Slough, 3 miles long, backed up by the Mokelumne; and of Kings River Slough, held up for a slender length of 10 miles by the San Joaquin. Although these little lakes have no renown outside of the State, hardly indeed, outside of their county, they provide for their neighboring residents a pleasing departure from the monotonous flatness which characterizes scores and scores of miles of the vast intermont plain, known as the Great Valley.

An example of a laked side stream in a mountain valley is found in the curved range which encloses the Great-Valley plain on the south. The upper part of Grapevine Canyon, the mouth of which holds an extinct landslide lake as told above, has a flat floor heavily aggraded with detritus, perhaps supplied by a landslide in its headwaters. In consequence of this a side valley up stream from Old Fort Tejon is ponded in the shallow Lake Castaic; but the lake is often dried off and then one sees only its white, playa-like bed. This lake "is of gruesome memory; for old-timers will tell you that once upon a time some exasperated white men, of the type that modern lynchers are made of, drove a whole village of Indians, men, women, and children, into it, because it was assumed that some of the number were responsible for the murder of the cook and a boy at Fort Tejon." [56]

Many little wet-weather ponds, from a quarter of a mile to a mile across, are found on the plain of the Great Valley between San Joaquin and Kings rivers, as shown on Conejo, Fresno, San Luis Ranch and Ingomar sheets of the U. S. Topographic Map. Their origin is not clearly understood.

Lakes barred by Fan Deltas

A few small examples of lake of this class have already been given; first, the little Blue Lakes that are associated with the above-described

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[55] State of California, Dept. of Public Works, Water Resources Bull. 28, 1931. See p. 253.

[56] Saunders, C. J. The Southern Sierras of California. Boston, 1923. See p. 74.

Clear Lake of landslide origin; later, the glacial Twin Lakes that are divided by the fan-deltas of opposite side streams. The examples now to be described are of much greater size. The extensive and low-grade detrital fans that are spread out by Kings and Kern rivers as their contribution to the vast intermont basin-plain of the Great Valley, have obstructed the weak drainage of its drier southern part, and evanescent lakes have thus been formed. Tulare (Spanish for reed-marsh) Lake, south of Kings River fan, was formerly a shallow water-sheet, many miles across; it is now hardly more than a marsh, since the greater part of its water supply has been withdrawn for irrigation.

The following account of the extinct Tulare Lake is condensed from the ''Official Historical Atlas of Tulare County,'' published in 1892 by the County Supervisors. In the early years of American occupation the lake measured at high water 44 by 22 miles and its area was 760 square miles; in 1891, it had shrunk to 22 by 17 miles and its area was 195 miles. It fluctuated greatly in level, having stood at 220 feet above Suisun Bay in 1862 and 192 feet in 1883. In the flood season of 1862 the attempt was made to run a stern-wheel steamboat from the San Joaquin River to the lake, but the steamer grounded and for many years after the hull and the stern-wheel were incongruous objects on the dry plain. However, in 1875 a small steamboat was built on the lake and used as a pleasure and freight boat for some years; several smaller boats have also been launched there for business and pleasure. In 1891 fish abounded, and terrapin were shipped in large quantities to the San Francisco market. The shallow waters as well as the surrounding marshland were then a favorite resort for water fowl, such as swans, cranes, curlews, duck, geese, and snipe.

Buena Vista and Kern lakes, 7 by 5 and 6 by 4 miles when flooded, are shallow and vacillating water sheets near the southern end of the Great Valley plain, where they are held by the low delta of Kern River just as Tulare Lake was formerly held by the delta of Kings River. They are said to be reduced to hayfields in summer, and even in winter their flooding is lessened by a canal leading northward where the front of the delta meets the western hills. The plain of Buena Vista Lake, shown on Mouth of Kern topographic map, does not vary 5 feet in altitude across a breadth of 6 miles.

By far the largest delta-barred basin in California, and probably the largest in the world, is found where the northwest end of a great intermont trough of depression is separated by the delta-plain of the Colorado River from its much longer and deeper southeastern part, which is occupied by the Gulf of California. As first described many years ago by Blake,[57] the basin was thought to have been occupied in large part by the head of the Gulf before the delta barrier was built; but it was understood that ''occupation of the valley by sea water * * * has extreme antiquity * * * dating back to Middle Tertiary,'' and that it gradually became fresh because of the flow of the Colorado River into it and its outflow by a channel along the delta front. The modern disappearance of the resulting lake was ascribed to evaporation in the arid climate there prevailing.[58] Later studies, especially those of Free[59] and Buwalda,[60] recognize the effectiveness of the delta barrier, but explain the basin that it encloses by the progressive depression of the land during the time of delta growth, so that although 2200 square miles of the basin floor are now below sea level, the deepest part being 275 feet below, it has never been overflowed by sea water.

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[57] Blake, W. P., Ancient Lake in the Colorado Desert. Am. Jour. Sci., 2d ser., vol. 17, pp. 435–438, 1854.

[58] Blake, W. P., The Cahuila Basin and the Desert of the Colorado. Carnegie Inst. Washington, Publ., 193, pp. 1–12, 1914. See p. 3.

The recent depression of the floor is attested by the occurrence of low fault scarps which cross the piedmont detrital fans built on the basin margin by inflowing wet-weather streams. The salt beds of the basin floor have been shown by Ross[61] to be of such composition that they are best explained, not by evaporation of an enclosed arm of the sea, but of a river-fed fresh-water lake. That such a lake has existed there is shown by its shore lines, about 30 feet above sea level; it must have been formed when the Colorado happened to flow westward into the basin, and the southward outlet of the lake must have followed the margin of the delta where it abuts against the western mountains. The lake necessarily disappeared by evaporation when the river chanced to give up its westward course and flow southward directly to the Gulf.

The present Salton Sea is a temporary water body that was formed on the floor of this great delta-barred basin by the accidental overflow of the Colorado River between 1905 and 1907. The water body then gained a size of 17 by 43 miles and an area of 410 square miles with a maximum depth of 83 feet, and thus became the largest lake in the State. Its area is now slowly decreasing by evaporation and it is destined to disappear. Accounts of it have been prepared by several observers.[62]

Plunge-Pool Lakes

A pool is excavated by the plunging water of a cataract. The plunge-pool of this kind beneath Niagara is about as deep as the falls are high. If the Niagara River were diverted to another course the pool would hold a small lake at the head of the river gorge. Some small lakes of this kind are known in south-central Washington, where the Columbia River, turned in the Glacial Period from its great northwest bend by the large Okanogan glacier from British Columbia, ran by a more direct course across the lava plains toward its canyon through the Cascade Mountains. It cut back a gorge on that temporary course, at the retreating head of which it plunged down in a great cataract, subdivided by several projecting ledges in the gorge-head cliff. When the invading Canadian glacier disappeared on the return of a milder climate in the Postglacial or present epoch, the river resumed its roundabout course and left the temporary course dry, except that several little lakes occupy the pools excavated by the plunging cataract. The site of the vanished cataract is now deservedly protected as a National Monument.

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[59] Free, E. E., Sketch of the Geology and Soils of the Cahuila Basin. Carnegie Inst. Washington, Publ., 193, pp. 21–33, 1914.

[60] Buwalda, J. P., The Salton Basin, Southern California. Science, vol. 71, pp. 104–106, 1930.

[61] Ross, W. H., Carnegie Inst. Washington, Publ., 193, pp. 35–46, 1914. See p. 46.

[62] Mendenhall, W. C., Ground Water of the Indio Region. . . . . U. S. Geol. Survey Water-Supply Paper 225, pp. 21–24, 1909.

MacDougal, D. T., and others, The Salton Sea. . . . . Carnegie Inst. Washington, Publ., 193, 1914; also Am. Jour. Sci., 4th ser., vol. 39, pp. 231–250, 1915.

Kennan, George, The Salton Sea, 1917.

Mention is made of this kind of lake in order to note that miniature water pools of the same kind occasionally occur in the valleys of desert mountain ranges in the southeastern part of the State, where short-lived torrents fed by summer cloudbursts excavate minute plunge-pools along their steep courses. The pools are known as 'tanks,' and also by the Spanish name, 'tinajas,' or water jars. They are usually more or less filled with boulders and gravel, but they also hold water for a time after a flood and are then the only available water supply

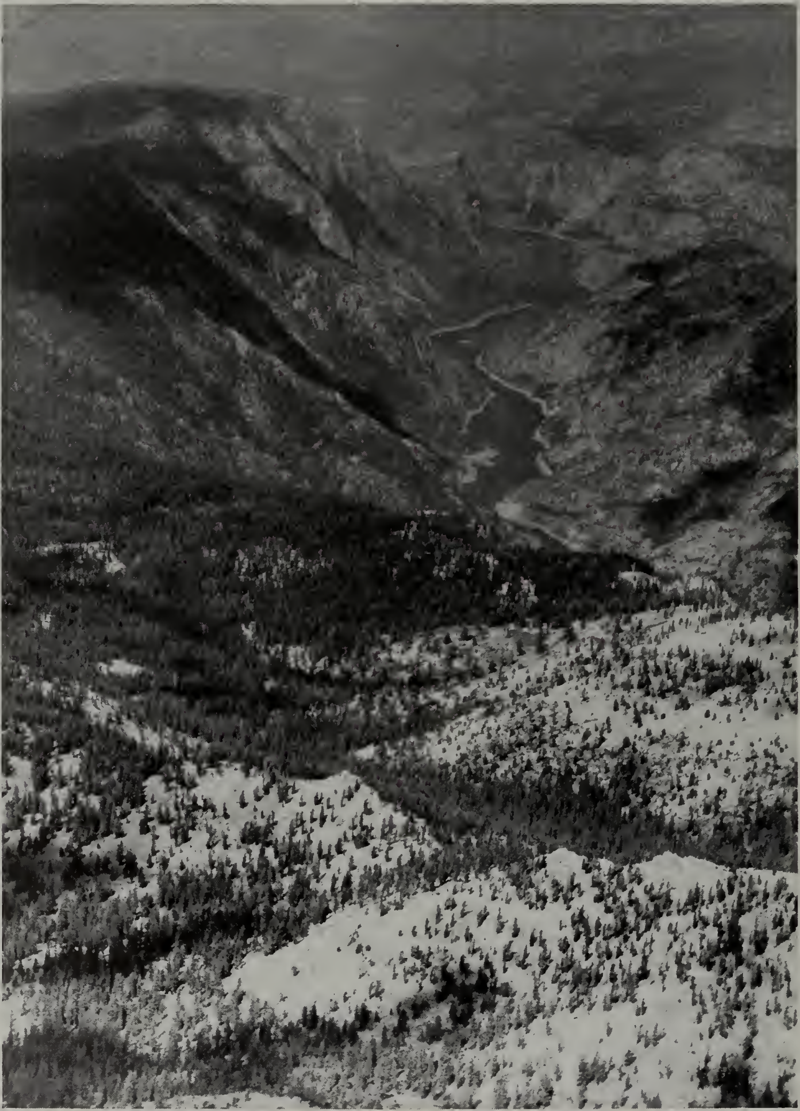

FIG. 23. Air-view of Hetch Hetchy Reservoir.

for miles around. Where water is priceless, little tinajas may rank as lakes.

The McCoy tanks are in a range of the same name 20 miles west of the lower Colorado. One of them is "a little bowl in porphyry. It is water-tight and holds water for several months." Farther north in the Little Maria Mountains, Mohave tank in granite has been "formed by flood waters pouring over a cliff about 15 feet high in the canyon bed"; in October, 1917, "a pool of water 12 to 15 feet in diameter and 2 to 3 feet deep stood in the little basin." It has never been known to be entirely dry and is "a favorite watering place for mountain sheep and other wild animals."[63] A detailed account of some remarkable tinajas in Arizona is given by Bryan.[64]

Lake-Like Reservoirs

Artificial reservoirs, constructed for the irrigation of agricultural lands or for the supply of municipal districts or of electric power stations, are truly lake-like in their appearance. Such reservoirs should be deep enough to prevent the growth of reeds, because when reeds are present they cause a great increase of evaporation, as noted above in the account of flood-plain marshes. A number of reservoirs are, indeed, natural lakes artificially enlarged. Some of these water bodies, like the backed-up lakes mentioned in the second preceding section, illustrate very clearly the manner in which the valleys of a subsiding coast are converted into bays. Many small reservoirs are not here listed.

Clear Lake, second largest of its name and already described as occupying a fault basin in the northeastern part of the State, is now enlarged in a reservoir measuring 8 by 3 miles. Big Sage, Thomas and Tule Lake reservoirs, of smaller size, the latter not to be confused with the vanishing Tule Lake farther north, are held in branch valleys of Pit River south of Goose Lake, and Britton reservoir is held in the valley of Pit River itself where it is cut through the northern mountains between Mt. Shasta and Lassen Peak. Mountain Meadow and Almanor reservoirs, 6 by 2 and 13 by 5 miles, lie in valleys of the North Fork of Feather River at the northern end of the Sierra Nevada proper, 25 and 35 miles west of Honey Lake: the former submerges part of Big Meadows, above described as the bed of a lava-barred lake; the latter is the largest reservoir in the State.

Farther south and mostly in or near the foothills of the Sierra Nevada, Pardee reservoir, 8 miles long, is on the Mokelumne; Woodward, 3 miles long, is on a small stream east of Stockton, and Melones, 5 miles long, is on the Stanislaus River. The glacial Lake Eleanor, 1 by 1½ miles, in the mountains on an upper branch of Tuolumne River, has been enlarged in a reservoir 2½ miles in length.

On the upper Tuolumne is the famous Hetch Hetchy reservoir (Fig. 23), 8 miles long, in a wonderful trough of the Yosemite type. The proposed construction of this reservoir aroused nation-wide opposition. Many lovers of nature, among whom John Muir was most widely known, protested that the great scenic attractions of the valley would

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[63] Brown, J. S., The Salton Sea Region, California. U. S. Geol. Survey Water-Supply Paper 497, 1932. See pp. 111, 264, 275, 276.

[64] Byran, Kirk, The Papago Country, Arizona. U. S. Geol. Survey Water-Supply Paper 499, 1925. See pp. 123–131.

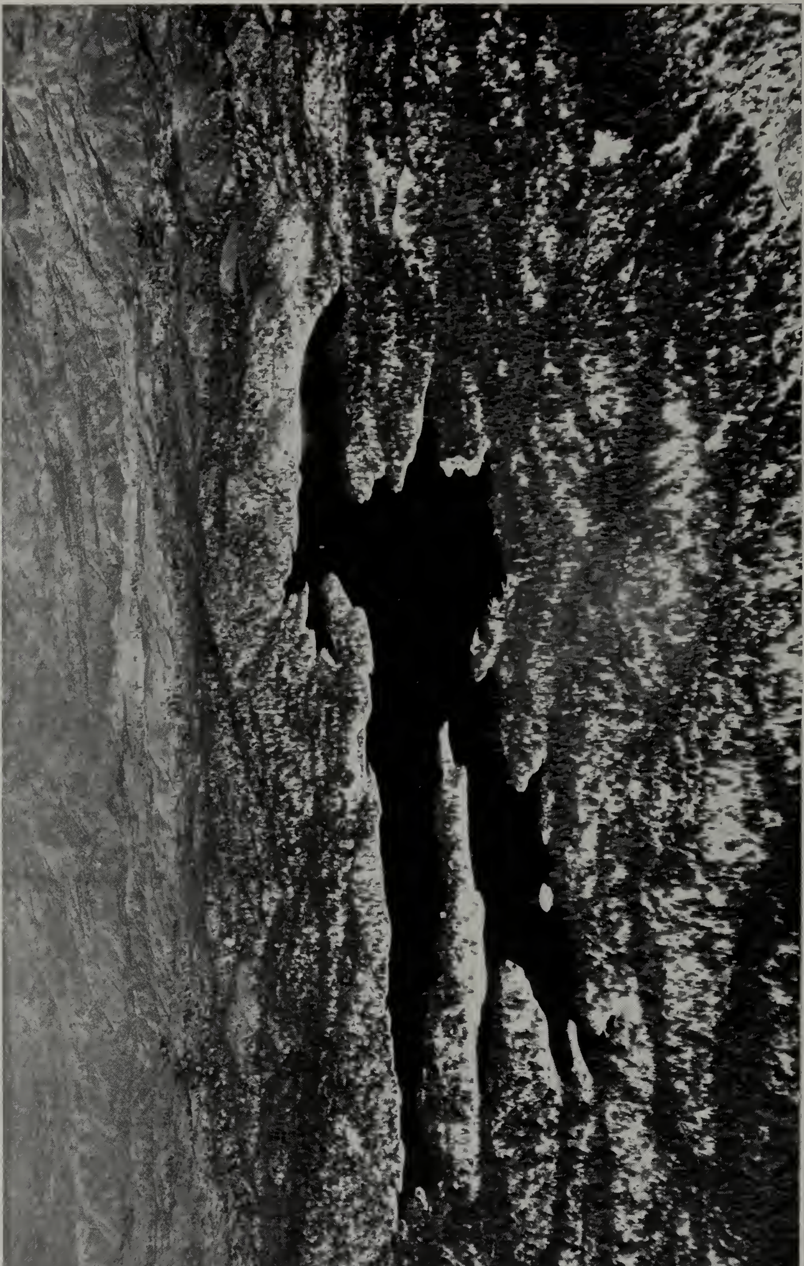

FIG. 24. Air-view of Arrowhead Reservoir.

be diminished if it were laked;[65] but the pressing need of a better water supply for the cities of the San Francisco peninsula, supported by the profitable use of the water in its descent from the high-level reservoir in furnishing electric power, overcame the esthetic protests. Although a reservoir in a mountain valley is evidently a modification of nature, it is not necessarily a disfigurement; and the artificial production of a beautiful reservoir in Hetch Hetchy Valley may be taken as a compensation for the destruction by natural processes of the lake which in prehistoric times beautified the Yosemite.

Farther down Tuolumne River are Don Pedro reservoir, measuring 7 miles in its bent length, and Owens reservoir, 4 miles long. Exchequer reservoir on the lower Merced River is of irregular outline and measures 12 miles in its winding length. In Owens Valley at the eastern base of the southern part of the same range, Upper and Lower Haiwee reservoirs, each about 3 miles long, are on the line of the Los Angeles aqueduct, south of Owens Lake.

Bear Lake, 6 miles long, and Arrowhead Lake, 2 miles long, are reservoirs in the highlands of the San Bernardino mountains; the latter is shown in Fig. 24.

All these reservoirs resemble Clear Lake of the northern Coast Ranges, in that their dams obstruct valleys very much as its landslide does; but few reservoirs resemble Clear Lake in having their outflow diverted from the valley by which their waters were formerly discharged. Two exceptional cases somewhat of that kind deserve special mention: One is Echo Lake, south of Lake Tahoe, already mentioned as having its waters diverted from the north and east-flowing Truckee River to the headwaters of the west-flowing South Fork of American River. The other, Pilsbury reservoir, 6 by 2 miles, occupies the branching headwater valleys of Eel River in the Coast Ranges, about 20 miles north of Clear Lake: its outflow runs down the valley to the much smaller Van Arsdale reservoir, but there the outflow is led by a tunnel through a ridge at the head of Potter Valley, where it joins the East Fork of Russian River. In the same region of the Coast Ranges are East Park and Stony Gorge reservoirs, 25 and 35 miles northeast of Clear Lake.

In the San Francisco peninsula south of the Golden Gate the long trough that has been eroded on the San Andreas rift holds two reservoirs, known as San Andreas and Crystal Spring lakes, 3 and 6 miles long when filled to capacity. In the Mt. Hamilton Range southeast of San Francisco Bay, two reservoirs, Chabot, 2 miles long, and Calaveras, 3 miles long, contribute to the pressing need of larger water supply for the growing bay cities.

Santa Barbara reservoir, 4 miles long, is in the valley of the Santa Inez River, north of the east-west mountain range of the same name. Arrowhead reservoir, 2 miles long, and also the artificial enlargement of the above-mentioned Bear Lake, 5 miles long when filled to capacity, are on the highlands of the San Bernardino and San Gorgonio mountains. Inland from San Diego and not far north of the Mexican boundary are Sweetwater, Lower Otay, Barrett and Moreno reservoirs, 4, 3, 6, and 3 miles in length. Farther north are the slender Hodge reservoir, 6 miles long, and the broader Henshaw reservoir, 5 by 4 miles.

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[65] See Muir's article, The Hetch Hetchy Valley, Sierra Club Bulletin, vol. 6, pp. 211–222, 1908, which includes a fine view of the valley in its natural state.

Here may be briefly mentioned the shallow water sheets of artificial origin, covering square-mile sections or quarter-sections on the level, Great Valley plain, maintained by various gun-clubs in order to attract migrating water-fowl. Several of them are shown on the Hamlin School and Miramonte sheets of the U. S. Topographic Map. They remain dry through most of the year, but are flooded by pumping up ground water late in the autumn and so remain into the winter. It is estimated that 1,000,000 wild ducks are shot yearly on these ponds. In their temporary existence they are but little longer lived than the mirages of the desert playas.

The Nile has a lake-like appearance where it spreads over its flood plain above the great dam at Assouan in Egypt. A great and deep-branching lake is now in process of production on the Colorado River by the building of the Hoover Dam in Black Canyon, to which the name of Boulder Canyon, next upstream, is popularly given.

Lake-Like Bays and Lagoons

A number of coastal bays, more or less completely enclosed from the ocean, gain a lake-like appearance. One of them, the Bay of San Francisco, by far the greatest in area as well as in importance in California, is also one of the most famous arms of the sea in the world. Like other famous sea arms, such as the magnificent bay on which the city of Rio de Janeiro is situated in Brazil, or the beautiful bay on which Sydney is situated in Australia, this lake-like bay in California is due to the submergence of former valley-like lowland areas in consequence of a slight subsidence of its district, and the same subsidence converted a former river-cut gorge in the coastal mountains into the famous Golden Gate.

Although the original area of the bay has been considerably diminished by the growth of salt marshes in its shallow shore waters, the main body, San Francisco Bay, still measures 47 by 5 to 12 miles; its northern extension, San Pablo Bay, set apart from the main body by a peninsular arm of the east shore, is 14 miles across; here the muddy water from the rivers of the Great Valley and the clearer water of flood-tide from the ocean are often distinguishable on opposite sides of the bay by their contrasted colors. The innermost reach above Carquinez Narrows is Suisun Bay, 14 by 2 to 6 miles, much shoaled and encroached upon by the marshy delta-lands of the Great Valley rivers.

This great bay may be compared with Clear Lake, in the Coast Ranges 100 miles to the north, because, as has been told on an earlier page, the lake, like the bay, has recently flooded part of an aggraded intermont plain. To be sure, the bay is of salt water at sea level, while the lake is of fresh water at an altitude of 1300 feet; the bay has flooded a large part of an extensive pre-existent plain because that part of the plain was depressed below sea level, while the lake has flooded part of a smaller plain because the drainage outlet of the plain was recently obstructed by a landslide; the bay has become an active center of population, industry and commerce, thereby gaining world-wide fame, while the lake preserves a quiet, rural quality which adds to its charm; but the resemblances of the two as well as their differences deserve recognition.

All the other lake-like bays of the California coast are of much smaller size. Beginning at the north they are as follows: Earl Lake, 1 mile by 6, and Talawa Lake, about 3 miles long, are both, the first behind the second, enclosed by a long, wave-built, smoothly beached sand reef, which swings out to a low rocky headland next north of Crescent City, 10 miles south of the Oregon line. The two lakes are separated by a narrow strip of sand which may be an earlier-formed reef of somewhat sharper curvature than the outer reef; for such curvature would have suited the beach drift very well before the cliffs to the north were cut back as straight as they are now. On smoothly curved beaches of this sort (Fig. 25), in adjustment with the approach of the surf because formed under its control, a long line of breakers plunges almost simultaneously in calm weather for miles together.

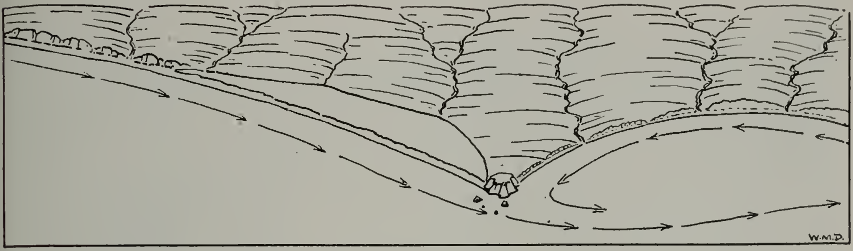

FIG. 25. Diagram of lagoon enclosed by a wave-built beach.

In consequence of a slight submergence of the coast, Klamath River is embayed for about 2 miles back from its mouth, which is partly closed by a sand spit. Farther south, where the strongly cliffed coast is adventurously followed by the Redwood Highway high above sea level, three valleys, slightly embayed by the same submergence of the coast, are closed somewhat as in Fig. 26 by heavy sand reefs, on which drift logs abound: the first is Freshwater Lagoon, Fig. 27, about a mile across its front; closely following is Stone Lagoon of larger size; third and farther south is Big Lagoon, 3 miles across. The

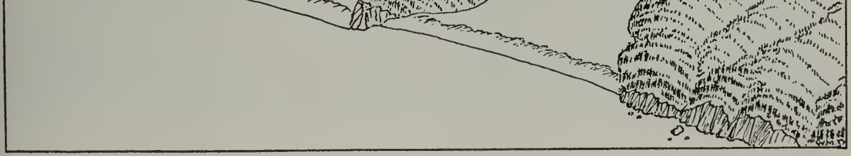

FIG. 26. Diagram of lagoons enclosed by wave-and-current-built beach on a coast embayed by slight subsidence.

fresh water in these enclosed bays, supplied by streams and springs from the backland, stands a little higher than mean sea level and is discharged by percolating through the enclosing sand reef. Roughly 20 miles farther south the saline waters of Humboldt Bay appear to invade three separate valleys, all enclosed by a single sand reef with a tidal inlet near the middle of its 13 miles of length; the northern and southern embayments are each 4 miles long; the middle one has a much smaller inland reach; all are diminished in area by invading deltas. The city of Eureka lies next south of the northern embayment. Eel River, 5 miles to the south, might also mouth in a bay, had it not been silted up by that good-sized stream, which is many times larger than the little creeks of the Humboldt embayments.

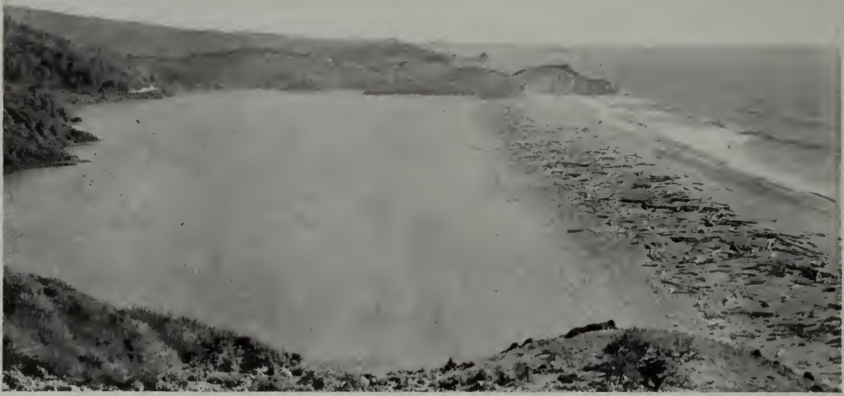

Photo by Patterson Bros., Santa Rosa.

FIG. 27. Freshwater Lagoon, below the Redwood Highway, north of Eureka; looking south.

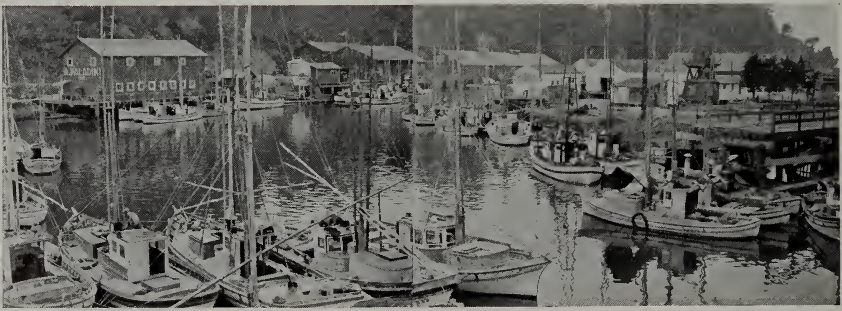

Photo by Olaf P. Jenkins.

FIG. 28. The embayed mouth of Noyo Creek, Mendocino County.

No bays of importance are found in the following 170 miles of the mountainous and boldly cliffed coast; but practically all the streams, none of them of great size, which there issue from the mountains, mouth in small fresh-water lagoons held back by heavy beaches. The streams may break through the beaches at times of flood; at other times their small discharge is accomplished by percolation through the beach sands. One such enlarged stream, the Noyo, Fig 28, offers a striking contrast to its solitary neighbors as it swarms most picturesquely with little fishing boats, for which an artificial cut through the enclosing beach is maintained; not that the slightly enlarged stream is a commodious harbor, but that the cliffed outer coast is absolutely harborless. Several other similarly enlarged streams served as local harbors for the lumber industry some 15 or 20 years ago; but their use has now either decreased or ceased with the decline of lumbering thereabouts.

At the end of the 170-mile stretch of harborless coast Russian River, having made its way in a fine, 13-mile gorge through the coastwise ranges, is enlarged by slight submergence into an estuary a mile or more in length, nearly closed at its mouth by a beach, of which Holway gives a good illustration.[66] Five miles farther on, Bodega Head, originally a two-mile, rocky island separated by a mile-wide strait from the coast, is now land-tied by a broad beach which is swept out to it from the shore on the north by the long-shore beach drift, thus transforming the strait into a bay open to the south; and a smaller beach, built by a backset or beach drift from the shore on the south, nearly encloses the bay; only a narrow tidal inlet is left open next to the end of the rocky island. A striking feature of the bay is the great drove of large dunes, the sands of which, impelled by north-west winds, are slowly climbing over the broader beach and the northern part of the rocky island and invading the bay, somewhat as drawn in Fig. 29. The dunes make a delightful summer picnic ground when the inland plain of the Great Valley is blazing hot!

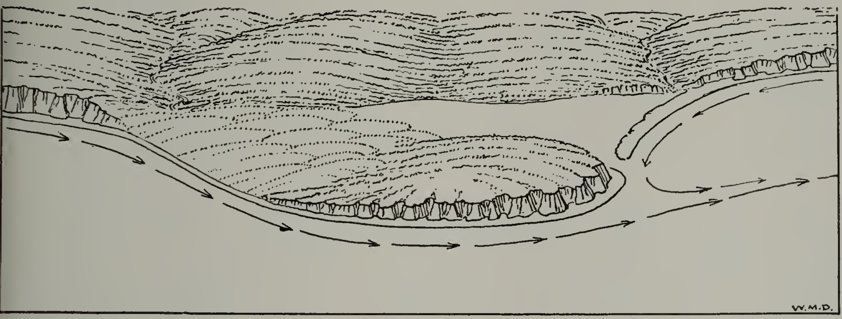

FIG. 29. Diagram of a land-tied island with a bay behind it, closed by a sand-reef beach controlled by a back-set eddy current.

Two miles to the south is the little Estero Americano, or American Estuary, like the Russian River estuary except in being of much smaller size and more completely closed. Then come Tomales and Bolinas bays, which head against each other in the party submerged depression that has been worn down on the shattered rock of the San Andreas rift, and which thus nearly insulate the Point Reyes peninsula. The strait that has been transformed into the above-named Bodega Bay lies in the northern continuation of this rift depression. Tomales Bay, opening to the north, is 16 miles long by a mile or so wide; it is imperfectly enclosed by a beach and bar, wave-driven from the north. Bolinas Bay, originally opening to the south and measuring 1 by 4 miles, is now almost closed by Stinson Beach, which is driven obliquely across its mouth by a backset beach drift from the south. The sands for this beach appear to be derived chiefly from the cliffs south of the Golden Gate, whence they travel 20 miles northward, making their way across the entrance to the Golden Gate along its offshore, submarine bar, curved on a 5-mile radius, before reaching the beach.

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[66] Holway, R. S., The Russian River, a Characteristic Stream of the Californian Coast Ranges. Univ. Calif. Publ. Geogr., vol. 1, pp. 1–60, 1913.

It is because of this northward shift of the sands that the surviving inlet of Bolinas Bay is at the northwest end of the enclosing beach; and it is because Bolinas is much smaller than Tomales and therefore has weak tidal currents that it is so much better enclosed. Its inlet exhibits a typical example of what may be called a double-headed tidal delta, the outer head of which is built out in a slight salient by the ebb tide and smoothed off by the shore waves, while the much larger and more freely branching inner head of the delta is built by the flood tide in the quiet waters of the bay.

On the south side of Point Reyes peninsula, which makes out between Tomales and Bolinas bays, is Drakes Estero, a fine embayment 4 miles long, with 3 arms that branch into as many valleys in the hilly uplands; it is enclosed by a beach formed by back-set drift, farther northwest than the one which encloses Bolinas Bay. Three smaller embayments of similar origin are near by; two lie next to the east on the southern coast, and one on the northern coast of the wave-trimmed peninsula.

Five miles south of the Golden Gate is Merced Lake, a true lake in being of fresh water, with two 2-mile arms that enter the hills of the San Francisco peninsula and are enclosed by the broad beach of its ocean shore and by the sand dunes that are swept by the westerly winds from the beach.

Several lagoons lie back of the 25-mile beach and dunes of the wide-open Monterey Bay, the middle of which lies 80 miles south of the Golden Gate. Two of the largest are expansions of Salinas and Pajaro rivers; but three others, one of which is known as Elkhorn Slough, do not appear to be related to stream courses. Some of these lagoons communicate with the ocean by narrow tidal inlets, but the Salinas lagoon is enclosed by a sand beach, except when floods from winter rains break through it. Near the southern end of the long beach several minute brackish or salt pools, which are said by Galliher in his account of Monterey Bay to have biological affinities with desert saline lakes,[67] lie back of the invading dunes.

Farther south, the bold and strongly cliffed coast of the Santa Lucia Range extends practically without a bay for 100 miles. All of the streams that here discharge directly to the ocean are of small size; they seem to be slightly embayed by submergence and the little coves are lagooned by beaches. Beyond this long and high range, which runs parallel to the coast, are several shorter ones which trend more to the southeast and head abruptly at the shore. Between them lie aggraded plains, well beached and duned; and back of the first beach of this series is Morro Bay, 3 by 2 miles, the beach of which has been guided by back-set beach drift. The town of San Luis Obispo stands at the head of the plain, 13 miles back from the bay. The next intermont plain, on which Santa Maria is the chief town, is heavily invaded by dunes from its beached front: here, a few miles inland is the small Guadalupe Lake; it was probably of greater size before the invasion of its area by dunes.

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[67] Galliher, E. W., Sediments of Monterey Bay, California. California State Min. Bur., Mining in California, January, 1932, pp. 42–79, 1932. See Fig. 5 and pl. III.

Then for over 30 miles southward to Point Conception, for 60 miles eastward along the Santa Barbara coast of the east-west Santa Inez Range, and for 30 miles southeastward along the lower Ventura coast to the east-west Santa Monica Range, no bays or lagoons are mapped, apart from a few small pools, such as those back of the long Hueneme beach of the Oxnard plain in the last 10 of the total 120 miles. Only at the end of that distance is there a narrow, beach-enclosed, tidal lagoon a few miles in length at the western end of the Santa Monica Range.

The 30-mile southern coast of that range is again without embayments; and not till a long beach swings southward from it is a little tide-marsh bay enclosed in the low coast lands; the shore resort of Venice lies on the enclosing beach, 15 miles west of Los Angeles. A few miles farther south rises the promontory of the San Pedro Hills, formerly an island; after it is rounded and the coast trends east again, Wilmington Lagoon, 3 miles long with 3 miles more of tidal marsh, lies back of a long beach that has been built westward by back-set beach drift, so that its tidal inlet is driven against the eastern base of the San Pedro Hills.

The back-set beach drift which has built this beach is, like several other drifts of the same kind mentioned above and one more to be mentioned below, the result of a coastal promontory or salient which holds the dominant southeastward sea current offshore. The lagoon, now provided with an artificial entrance cut through its beach and improved with wharves and docks, serves as the harbor for the growing maritime commerce of Los Angeles, which lies 20 miles inland to the north. The shore resort of Long Beach is at the east end of the lagoon. Beyond it are four more beach-barred lagoons of smaller size.

Farther on still is a marsh that might be a good-sized beach-barred bay, had it not been silted up by the Santa Ana River, the largest stream of southern California. Then comes the bay known as Newport Harbor, 5 miles long at high time, shut in by a broad, wave-driven and southward-growing beach, on which a summer population gathers; the tidal currents at the harbor entrance are dangerously strong; the Santa Ana River, deflected southward by the wave-driven beach, used to mouth through this bay; it now has an artificial mouth farther north, cut through the long beach that encloses its marshes.

The following coast is, apart from two small salients, rather smoothly cliffed and beached in a long southeastward curve for over 60 miles; but near the middle of that distance half a dozen small streams, apparently a little drowned at their mouths and more or less marshed, are beach-barred. Next comes Soledad Mountain back of La Jolla, beyond which False Bay is another beach-enclosed embayment, 2 by 3 miles, again with dangerous tidal currents at its inlet. Finally, beyond the southward-stretching peninsula of Point Loma, San Diego

Bay is reached, 12 by 2 or 3 miles, enclosed by a long beach, built northward from near the Mexican boundary by a wave drift to the low Coronado Island. This beach, 12 miles in length, is the finest example of its bay-enclosing kind in the State. One of the longest beach-enclosed lagoons in the world stretches northward for scores of miles in a graceful curve from the Rio Grande delta along the low coast of Texas.

Conclusion

In closing this review the author desires to remind his readers once more that the study of Californian lakes is by no means complete. It is therefore eminently possible that further investigations will lead to many new descriptions as well as to corrections in some of the foregoing descriptions. But if lovers of nature, young as well as older, gain an increased enjoyment of Californian lacustrine scenery by reason of what is here told of its origins, and if some of the more observant among them are thereby incited to make new investigations of the ways in which Californian lakes are brought into being, the enjoyable labor of gathering the material presented above will be doubly repaid.

OIL FIELD DEVELOPMENT OPERATIONS

R. D. Bush, State Oil and Gas Supervisor

From October 2, 1932, to and including December 31, 1932, the following new wells were reported as ready to drill:

Company	Sec.	Twp.	Range	Well No.	Field
FRESNO COUNTY:					
Kettleman North Dome Association	20	21	17	38	Kettleman North Dome
Kettleman North Dome Association	32	21	17	61	Kettleman North Dome
Superior Oil Co.	29	21	17	Huffman 5	Kettleman North Dome
Union Oil Co.	29	21	17	King 3	Kettleman North Dome
Bergman Oil Co.	12	12	11	1	
Graham-Loftus Oil Corp.	20	15	18	1	
GLENN COUNTY:					
Tehama Petroleum Corp.	4	22	5	1	
KERN COUNTY:					
Belridge Oil Co.	35	27	20	20-35	Belridge
Milham Exploration Co.	1	28	22	S. P. 41-1	Buttonwillow Gas
Milham Exploration Co.	1	28	22	S. P. 43-1	Buttonwillow Gas
Milham Exploration Co.	6	28	23	Sisson 1	Buttonwillow Gas
Milham Exploration Co.	8	28	23	Whitaker 2	Buttonwillow Gas
Fruitvale Oil Co., Ltd.	15	29	27	Lane 1	Fruitvale
Powell-Stockton Investment Co., Ltd.	15	29	27	Powell-Stockton 1	Fruitvale
Associated Oil Co.	2	26	20	Williamson 1	Lost Hills
Belmont Midway Oil Co.	22	32	23	1	Midway
Darby Syn.	22	32	23	Cypress 1	Midway
North American Oil Cons.	32	31	24	25	Midway
Julian J. Miley	27	26	28	Salisbury 1-A	Mt. Poso
Shell Oil Co.	9	27	28	Vedder 6	Mt. Poso
California Western Oil Co., Ltd.	7	28	29	11	Round Mountain
Coffee Petroleum Corp.	6	28	29	3	Round Mountain
Howells Brothers	32	28	29	Howells 1	Round Mountain
Petroleum Securities Co.	6	28	29	Coffee 3	Round Mountain
Ralph Lavin, Harrie P. Avery, and D. W. Jordan	20	11	23	2	Sunset
KINGS COUNTY:					
Associated Oil Co.	35	21	17	Whepley 4	Kettleman North Dome
Standard Oil Co.	35	21	17	25	Kettleman North Dome
Kettleman Pacific Corp.	11	23	16	Baby King 2	
LOS ANGELES COUNTY:					
Union Oil Co.	33	3	13	Hellman 19	Dominguez
Bess & Hughes, Inc.	24	4	13	Kronick 1	Long Beach
Charles W. Fourl	19	4	12	4	Long Beach
The Hancock Oil Co.	19	4	12	Signal 31	Long Beach
Lexington Oil Corp.	24	4	13	Indian 9	Long Beach
J. E. O'Donnell	24	4	13	Walker 2	Long Beach
West American Oil Co.	19	4	12	8	Long Beach
West American Oil Co.	19	4	12	9	Long Beach
West American Oil Co.	19	4	12	10	Long Beach
S. S. Wortley	24	4	13	4	Long Beach
Young Petroleum Corp., Ltd.	29	4	12	Hilton 3	Long Beach
W. L. Alexander	1	3	16	Alexander 1	Newhall
Big 4 Oil Co.	32	4	16	Brona 1	Newhall
Union Oil Co.	27	2	15	Del Rey 5	Playa del Rey
Union Oil Co.	27	2	15	Del Rey 5	Playa del Rey
Union Oil Co.	27	2	15	King Vidor 2	Playa del Rey
Andrus & Hutcheson, Inc.	11	1	11	A. & H. 1	
Wilmington Terminal Oil Co.	28	4	13	1	

Company	Sec.	Twp.	Range	Well No.	Field
MONTEREY COUNTY:					
Thomas Petroleum Corp.	31	22	14	Flentge 2	
Western Gulf Oil Co.	29	12	2	Johnson 1	
ORANGE COUNTY:					
Matilda Shallemiller	32	5	11	1-B	Huntington Beach
Southern California Drilling Co.	10	6	11	Severns 1	Huntington Beach
RIVERSIDE COUNTY:					
Harry J. Keeley	21	4	6	Keeley-Damron 1	
SANTA BARBARA COUNTY:					
Barnsdall Oil Co.	15	4	29	88-9	Elwood
R. H. McIntosh	28	4	27	Roskop 1	Mesa
B. L. Webb	28	4	27	1	Mesa
VENTURA COUNTY:					
A. N. Macrate	27	4	23	Riva Kosmon 1	Ojai
Sovereign Oil Corp.	23	4	19	Leavens-Goodenough 1	Piru
Charles and Hoxie Anderson	36	3	18	Marr 12	Simi
Associated Oil Co.	27	3	23	Lloyd 132	Ventura
Livermore and Kennedy	33	4	23	22	Ventura
Livermore and Kennedy	33	4	23	23	Ventura
Shell Oil Co.	30	3	23	Taylor 75	Ventura

SPECIAL ARTICLES

Detailed technical reports on special subjects, the result of research work or extended field investigations, will continue to be issued as separate bulletins by the Bureau, as has been the custom in the past.

Shorter and less elaborate technical papers and articles by members of the staff and others are published in each number of CALIFORNIA JOURNAL OF MINES AND GEOLOGY.

These special articles cover a wide range of subjects both of historical and current interest; descriptions of new processes, or metallurgical and industrial plants, new mineral occurrences, and interesting geological formations, as well as articles intended to supply practical and timely information on the problems of the prospector and miner, such as the text of the new laws and official regulations and notices affecting the mineral industry.

DISCOVERY OF PIEDMONTITE IN THE SIERRA NEVADA

By Evans B. Mayo *

An announcement of the discovery of the rare manganese-bearing epidote, piedmontite, in schistose volcanic rocks in the Sierra Nevada of northeastern Madera County, has been published,[1] but, since the article describing the occurrences appeared in print, the writer has had the opportunity of visiting the locality, in company with W. E. Selbie, its discoverer, and obtaining much better material than had been collected there before. The best single specimen found to date was sent to the museum of the State Division of Mines, where it is now on display. At the suggestion of the State Mineralogist, Walter W. Bradley, the following brief account of the finding of the mineral, a short description of the deposit, and notes on the character and relations of piedmontite, are herewith submitted. The collection and study were made while mapping southwestern Mono County under the auspices of the Geologic Branch of the Division of Mines.

In Madera County, piedmontite was first found in the course of a petrographic examination of a metamorphosed tuff, or lava, from Volcanic Ridge (see the Mt. Lyell topographic sheet, U. S. Geol. Survey), in which it appeared as a microscopic constituent, replacing original biotite.[2] Later, a specimen of pink, schistose rock, picked up along the trail about 200 yards below the outlet of Shadow Lake, was sent to the writer, by W. E. Selbie, for identification. This material which was found to contain abundant minute, needle-like crystals of piedmontite, was described in the paper referred to above. The following notes are based on the more recent visit to the locality, and on a brief inspection of the newly collected material, which is being studied in detail by Allan M. Short, a graduate student at Cornell University.

Location. Figure 1 is a view northwestward across the canyon of the Middle Fork of San Joaquin River, toward the Ritter Range, from the crest of the Sierra, south of San Joaquin Mountain. Unfortunately, Shadow Lake does not appear in the photograph, but its approximate position is indicated by the arrow, below which occurs the steeply-dipping, banded series of schists in which the mineral was found. The point at which Selbie first noted the pink and dark-red piedmontite-bearing rocks is marked 'X,' and the dotted line indicates the trace of a shear zone, parallel to the banding of the metamorphic rocks, along which hydrothermal solutions that deposited the piedmontite have risen. This zone appears from a distance as a dull red band, traversing the sombre gray volcanic schists. It has been examined only at one place, where it crosses Shadow Creek; but, judging from the color, it probably carries piedmontite over a length of about 2 miles, from some point a short distance south of Shadow Creek, to the head of the canyon of Middle Fork.

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* The writer wishes to express his appreciation to Professor H. Ries and Dr. J. D. Burfoot, Jr., both of Cornell University, for assistance in preparing this paper.

[1] Mayo, Evans B., Two new occurrences of piedmontite in California: Am. Mineralogist, vol. 17, pp. 238–248, 1932.

[2] *Op. cit.,* pp. 244–246.

The place where the deposit was discovered is situated in a gorge, through which the water of Shadow Creek leaps and foams from its hanging upper valley, to join the Middle Fork of San Joaquin River, in the bottom of its canyon, 600 feet below. The trail, constructed past Shadow Lake from the Middle Fork canyon, has been blasted out along the face of the nearly vertical cliffs in the gorge, which runs almost at right angles to the strike of the schistose volcanic rocks, mentioned above, so that the trailmakers had to construct their path directly across the shear zone containing the piedmontite. For a distance of 100 feet or more, the parapet along the outside of the trail is built of blocks of the pink to dark-red piedmontite-bearing schist. The specimen on display at the Museum of the Division of Mines is a block which was torn from the trail during the blasting. It is a part of the wall of a fissure, formed by shearing, and later filled with mineral matter (Fig. 2), including piedmontite, tremolite (variety asbestos), quartz, and an orange-colored garnet. This specimen was collected by Mr. Selbie on the face of the cliff about 50 feet below the parapet.

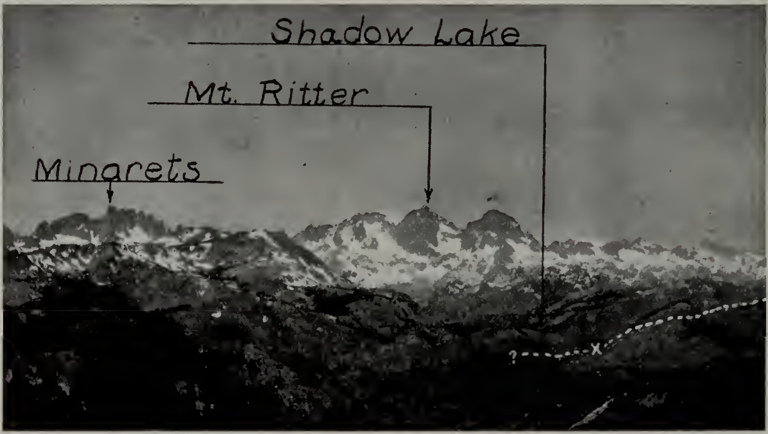

Fig. 1. Looking northwestward across the canyon of Middle Fork of San Joaquin River. The dotted line marks the piedmontite zone, while 'x' is the place of discovery.

Photo by Burt Beverly, Jr.

The Shear Zone. The width of this zone can not be accurately stated, because shearing, accompanied by strike faulting, appears to have been intense throughout the entire thickness of the volcanic schist formation,[3] but the band characterized by the piedmontite appears, on Shadow Creek, to be 100 feet or more in width, and within it much of the movement has been concentrated along a few narrow fissures, which doubtless represent fault planes. Along these fissures the mineralizing solutions rose most readily, although the schistose rock between the 'fault-veins' has itself been permeated to a lesser extent by the manganese-bearing emanations, with the result that piedmontite may be developed there as a microscopic constituent, in varying degrees of abundance, so that the rock varies in color from pink to dark red. It is of interest to note that the schists of the piedmontite zone are characterized by an important amount of a pink, sericitic mica, which probably contains a trace of manganese, although no analysis of it has as yet been made.

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[3] The character of these rocks, and the geology of the surrounding region, will be described in a report by H. D. Erwin, soon to be published by the Division of Mines.

Character of the Piedmontite. Several thin sections of the more coarsely-crystalline material from the 'fault-veins' have been prepared, and while a detailed description of these will not be attempted here, a short discussion of the nature and appearance of this rare and interesting mineral will be given. Megascopically, it appears as dark, purplish-red, or reddish-black, monoclinic crystals, elongated parallel to the b- or ortho-axis. If crystal faces are developed, those parallel to the b-axis will usually be striated lengthwise. In thin section, examined with plane polarized light, this mineral is truly magnificent, because of its peculiar property (known as pleochroism) of transmitting certain vivid colors of light in certain directions, so that, when the stage of the microscope is revolved, the piedmontite appears to change color, displaying various shades and tints of yellow, orange, amethyst, amethystine-red, carmine, and various intermediate colors, those seen in any individual depending upon the direction in which that particular crystal happened to be cut in preparing the slide. Figure 3 shows part of a thin section of the piedmontite of Madera County. The colors produced by the pleochroism are, of course, not shown. The tendency toward parallel orientation of the crystals has doubtless been produced by a continuation of some of the shearing movements during deposition of the minerals along the fissures.

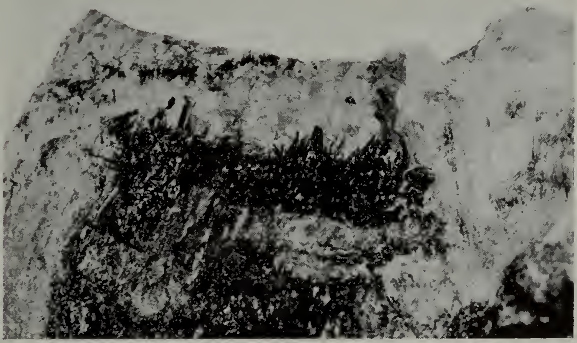

Photo by Burt Beverly, Jr.

FIG. 2. Portion of specimen now on display at the museum of the Calfornia State Division of Mines. The black prisms are piedmontite, and the silky material in the upper right hand corner is tremolite asbestos. Almost natural size.

It is not necessary to have a thin section in order to see the striking pleochroism of this mineral. Crushed fragments, mounted on a glass slide, in Canada balsam, some immersion oil, or even in a drop of water, are sufficient. Many of the fragments are prismatic in shape, the sides being determined by the cleavage, which is parallel to the b-axis.[4] When the sides of such a cleavage piece are parallel to the vibration direction of the polarizer, or lower nicol, the fragment appears colored some shade of amethyst, the depth of color depending upon the thickness of the grain. If the sides of the fragment are perpendicular to the plane of polarization of the lower nicol, the color seen may be carmine, yellow, or some intermediate tint. Other intermediate colors will be noted on rotation of the stage.

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[4] More specifically, the cleavage is parallel to the front (ortho) pinacoid, (100), and to the basal pinacoid (001).

The Relation of Piedmontite to the Epidote Group. The better-known epidote minerals are the following:

Formula	Crystal System	Name
$Ca_2(AlOH)Al_2(SiO_4)_3$	Orthorhombic	Zoisite
	Monoclinic	Clinozoisite
$Ca_2(AlOH)(Al,Fe)_2(SiO_4)_3$	Monoclinic	Epidote
$Ca_2(AlOH)(Al,Mn,Fe)_2(SiO_4)_3$	Monoclinic	Piedmontite
$(Ca,Fe)_2(AlOH)\ (Al,Ce,Fe)_2(SiO_4)_3$	Monoclnic	Allanite

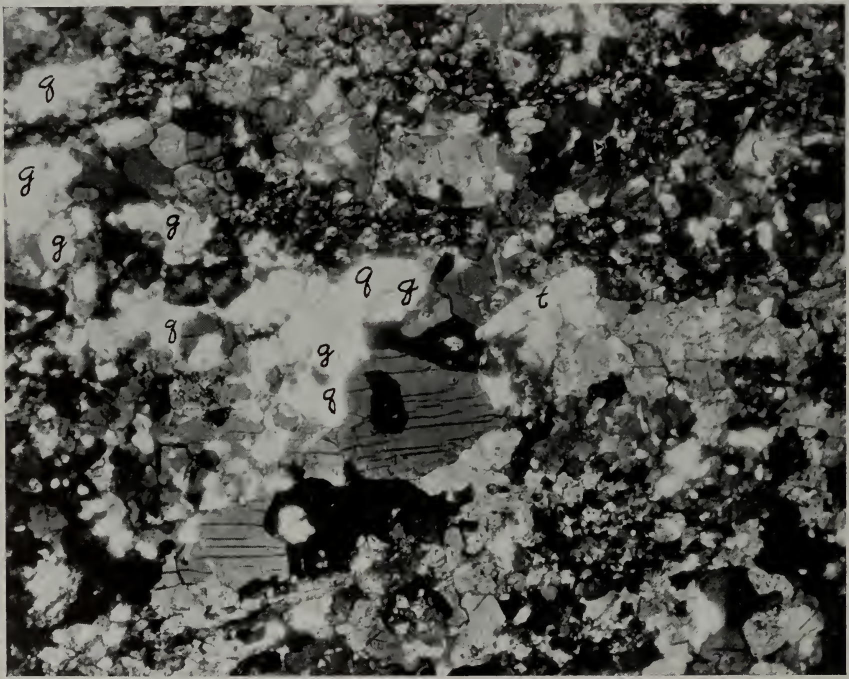

FIG. 3. (x 56) Photomicrograph made with plane polarized light, of thin section of piedmontite from Shadow Lake. Two large crystals of piedmontite in lower half of picture show cleavage traces. The mineral appears various shades of gray, or even black, because of varying intensity of pleochroism, due to haphazard orientation of the crystals, q–quartz; g–garnet, t–titanite. Most of the smaller white bodies are quartz.

All of the above minerals, except zoisite, have been identified by the writer in rocks from the eastern part of the Sierra Nevada, in Madera and Mono Counties. Doubtless few prospectors, or even summer visitors to this portion of the High Sierra, have failed to see the pistache-green crusts of common epidote lining joint planes in the rocks. In the areas of volcanic schists, there are localities at which epidote almost rivals the tiny, mossy meadows in giving a touch of color to the rather solemn-toned landscape. The dull red band, marking the course of the piedmontite zone along the canyon wall above the Middle

Fork of San Joaquin River, furnishes a local peculiarity which will probably not be duplicated elsewhere in the vast Sierra.

Other Californian Occurrences. The first notice of piedmonotite in California was that by A. F. Rogers, who found the mineral in a boulder from Pacific Beach, San Diego County.[5] A piedmontite-bearing rock fragment from San Bernardino County was later mentioned by A. S. Eakle.[6] The mineral was found as detrital grains in sediments near Lost Hills, in the southern part of the San Joaquin Valley, by Reed and Bailey,[7] and by E. Wayne Galliher among the heavy minerals in bottom samples from Monterey Bay.[8] A fairly complete list of occurrences in other parts of the world is to be found in the writer's paper, referred to at the beginning of this article.

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[5] Rogers, A. F., Notes on Rare Minerals from California. School of Mines Quarterly: Vol. 33, p. 378, 1912.

[6] Eakle, A. S., Minerals of California: Calif. State Mining Bur., Bull. 67, 1914.

[7] Reed, R. D., and Bailey, J. P., Subsurface Correlation by Means of Heavy Minerals: Bull. Am. Assoc. Petrol. Geol., Vol. 11, pp. 359–368, 1927.

[8] Galliher, E. Wayne, personal communication.

SUSPENSION OF ASSESSMENT WORK

The President on May 18th signed "Public Law No. 18," of the 73d Congress being "An act providing for the suspension of annual assessment work on mining claims held by location in the United States and Alaska," specifying that "the same is hereby suspended as to all mining claims in the United States, includng Alaska, during the year beginning at 12 o'clock meridian July 1, 1932, and ending at 12 o'clock meridian July 1, 1933: PROVIDED, That the provisions of this act shall not apply in the case of any claimant not entitled to exemption from the payment of a Federal income tax for the taxable year 1932: PROVIDED FURTHER, That every claimant of any such mining claim, in order to obtain the benefits of this act, shall file, or cause to be filed, in the office where the location notice or certificate is recorded, on or before 12 o'clock meridian, July 1, 1933, a notice of his desire to hold said mining claim under this act, which notice shall state that the claimant, or claimants, were entitled to exemption from the payment of a Federal income tax for the taxable year 1932."

Particular note should be made of two points: (1) Those persons or firms who were liable for the payment of Federal income tax for the calendar year, 1932, must do assessment work this year on mining claims in which they hold an interest. (2) A notice to hold claims under benefit of this moratorium must be filed by noon, July 1, 1933; said notice also to contain a statement of income tax nonliability.

While no particular form for the notice is specified it is suggested that the following will satisfy the requirements of the bill just signed by the President:

NOTICE OF DESIRE OF ________________________ TO HOLD THE ___________

MINING CLAIM FOR THE ASSESSMENT YEAR, 1932–1933.

Notice is hereby given by the undersigned ______________________________

that he is the claimant of the __________________________ Mining Claim situated

in ________________________ Mining District, County of ______________________ State of California and that he desires to hold said mining claim during the assessment year 1932–1933 under the provisions of the act of Congress entitled "An act providing for the suspension of annual assessment work on mining claims held by location in the United States and Alaska." Approved May 18, 1933.

That the location notice or certificate of said mining claim is recorded in the office of the county recorder of said county, (that being the proper office of record).

And notice is hereby further given by said *claimant* that he, said *claimant*, was entitled to exemption from the payment of a Federal income tax for the taxable year 1932. *

Dated this _________ day of _______________ 1933.

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Claimant.

* If several claimants join in giving this notice it should appear therein that *each* of them was entitled to said exemption.

TRACING BURIED-RIVER CHANNEL DEPOSITS BY GEOMAGNETIC METHODS[1]

By Elmer W. Ellsworth[2]

Introduction

This article attempts to present a study of the application of geomagnetic methods of surveying to the development of certain types of placer ground. It is directed toward the problem of tracing the courses of relatively deeply buried, auriferous channel deposits, especially those of the Tertiary rivers in California. The application of the magnetic method to the development of similar deposits with a shallow depth of cover has been brought out in earlier reports,[3] and therefore will not be discussed here in detail. The writer has felt that if it could be adequately demonstrated that geomagnetic surveying may be used successfully in the mapping of these buried-channel deposits, this knowledge would be of interest and value to the placer mining industry as a whole. The results of the present investigation are presented as illustrating the usefulness of the geomagnetic method in this type of exploration.

Need for a proper field test of the application of geomagnetics to work of this kind was sensed in a statement made by Walter W. Bradley in an article entitled 'Renewed Activity in California Gold Mining,' appearing in the September, 1932 issue of Mining and Metallurgy: "The surficial placer accumulations of gold have now been fairly well skimmed off, but there are portions of buried, ancient river channels, as yet unworked, with gravel containing sufficient gold to be workable by drift mining; others, less concentrated, contain gold economically recoverable by hydraulic methods." Accordingly, in order to determine the possibilities and limitations involved in this use of the magnetic method of geophysical prospecting, the writer undertook the supervision of such a test, and during November, 1932, several weeks of field work were performed in Placer and Plumas counties, in the northern Sierra Nevada. Before proceeding it may be well to define the term 'geomagnetics' as it is used throughout this paper. Applied geomagnetics, which after all is the type of geomagnetics in which we are most interested, may be defined as the practical application of magnetic surveying to the solution of geologic problems.

The data here presented are based upon a geomagnetic survey on the Forest Hill Divide, which is situated in south-central Placer County, California. This area was selected as one suited to the making of such a test since the auriferous channels here are buried under several hundred feet of volcanic capping, and maps are available which accurately show their courses. This survey was concerned with the problem of tracing the gold-bearing Blue Gravel Channel, or 'blue lead,' which is concealed under 100 to 400 ft. of cap rock.

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[1] Published by permission of the Pacific Coast Geophysical Service of W. C. McBride, Inc.

[2] Consulting Geologist.

[3] (a) Arthur Gibson: Magnetometric Determinations Applied to Placer Mining. Eng. and Min. Journal, Vol. 114, No. 25: 1064. 1922.
(b) K. C. Laylander: Magnetometric Surveying as an Aid in Exploring Placer Ground. Eng. and Min. Jour.-Press, Vol. 121:325–327. 1926.
(c) C. A. Heiland and W. H. Courtier: Magnetometric Investigation of Gold Placer Deposits near Golden, Colorado. Geophysical Prospecting, 1929, A. I. M. E.: 364–384. 1929.

The geophysical work on the Forest Hill Divide described in this article is one of 30 similar investigations which have been conducted in California during the past two years by the Pacific Coast Geophysical Service of W. C. McBride, Inc. The Hotchkiss Superdip magnetometer has been employed in all of these surveys. This sensitive instrument measures relative variations in the total intensity of the earth's magnetic field. These variations from the normal, or magnetic anomalies, are caused by local geologic structures that aid or hinder, or otherwise affect the passage of the lines of force in the earth's normal magnetic field. For the survey at Forest Hill the sensitivity of the instrument was adjusted so that a one scale division change in its reading was equivalent to a variation in the local magnetic field of approximately 12.5 gammas.

The writer wishes to acknowledge the assistance given in the field by Mr. George Duffey, superintendent of the Mayflower Gravel Mines, and by Mr. Harold W. Kirchen of the Pacific Coast Geophysical Service.

Geologic Conditions at the Forest Hill Divide

At the Forest Hill Divide the lower portions of the ridges are composed of metamorphic and igneous rocks. These are overlain by a volcanic capping that has a maximum thickness of 300 to 400 ft. This capping includes volcanic agglomerate and other sedimentary strata. Most of the auriferous channel deposits, such as the Blue Gravel Channel, or 'blue lead,' which has an average width of about 1000 ft., occur between the bedrock and the overlying strata, while others are confined to the lower portions of the volcanic capping. The courses of these buried channels, which are all of Tertiary age, bear no relation to the present topography of the district, thus rendering their exploration a difficult problem. At Forest Hill the course of the Blue Gravel Channel has been very accurately determined, in the area covered by the present survey, as a result of extensive workings.

Details of the Recent Survey

Parallel lines of traverse were laid out with stations set every 50 ft. (every 100 ft. along traverse A-B). The locations of these lines of traverse are shown in Figure 1. Traverse line C-D follows, approximately, the surface trace of the Independent and Excelsior Slopes of the Blue Gravel Channel. This line of traverse coincides with the location of the geologic section of the Independent Tunnel and Excelsior Slope, which is shown upon the geologic map of the Forest Hill Divide accompanying the Tenth Annual Report of the State Mineralogist. The geologic section presented in Figure 2 has been reproduced from this original section, the location of the mine workings having been omitted for the sake of clarity. Traverse line A-B lies 1000 ft. to the northeast, while line E-F is 100 ft. southwest from line C-D.

A series of magnetometer readings were taken at each station, and their mean, together with the temperature and time, were recorded. By returning to a base station several times during the day a close check was maintained on the value of the diurnal variation in the earth's normal magnetic field. After completion of these traverses the instrument readings were corrected for temperature and diurnal variations in the usual manner. The corrected readings were then plotted, and the resulting 'magnetic profiles,' which reveal variations in the total intensity of the earth's magnetic field along the respective lines of traverse, are indicated in the accompanying Figures, 1 and 2.

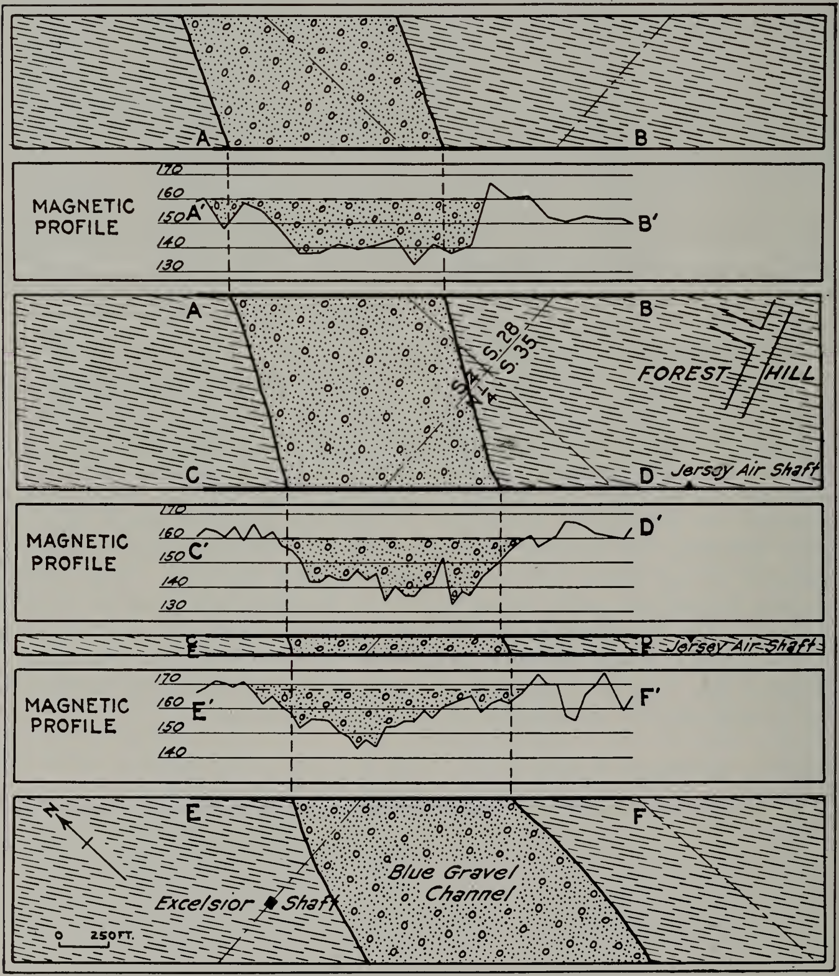
A
B
MAGNETIC PROFILE
170
160
150
140
130
A'
B'
A
B
S. 28
S. 35
S. 14
FOREST HILL
C
D
Jersey Air Shaft
MAGNETIC PROFILE
170
160
150
140
130
C'
D'
E
F
Jersey Air Shaft
MAGNETIC PROFILE
170
160
150
140
E'
F'
E
F
N
Blue Gravel Channel
Excelsior Shaft
0 250 FT.

FIG. 1. Map of a portion of the Forest Hill Divide, Placer County, California, together with three parallel magnetic profiles across the Blue Gravel Channel. The course of the magnetic 'low' indicated by these three profiles is seen to coincide with that of this buried, auriferous channel. This geologic map has been taken from that which accompanies the Tenth Annual Report of the State Mineralogist.

Results of the Geomagnetic Survey on the Forest Hill Divide

The results of the survey are presented graphically in Figures 1 and 2. In Figure 2 is shown one of the magnetic profiles with a plan view and geologic section of the corresponding line of traverse, C-D.

The magnetic profile has one outstanding feature. This is the magnetic 'low,' or minimum in the total magnetic intensity, which occurs directly over the Blue Gravel Channel. This anomaly immediately suggests itself as being the magnetic reflection of this channel. Referring now to Figure 1, it is seen that all three of the magnetic profiles across this channel present anomalies which are not only similar, but which occur in each case directly above the channel. The course of the magnetic 'low' thus mapped is found to coincide with that of the buried Blue Gravel Channel.

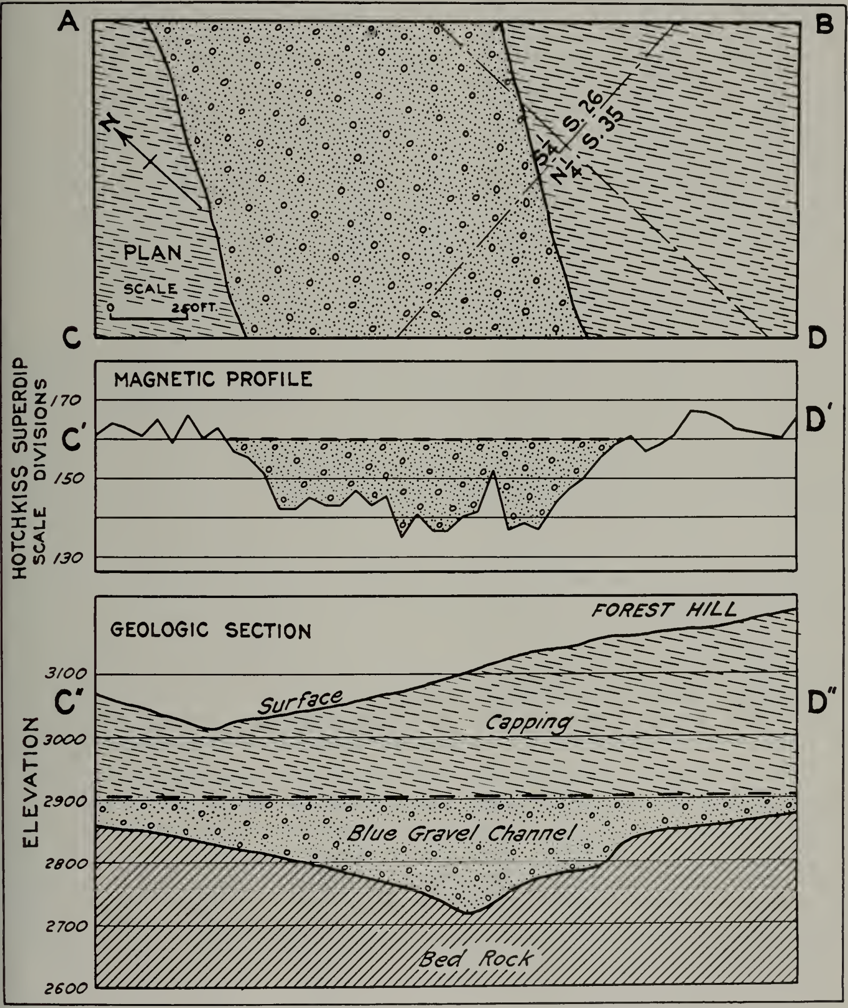
A
B
N
S. 26
S. 35
¼ S.
N ¼
PLAN
SCALE
0
250 FT.
C
D
MAGNETIC PROFILE
HOTCHKISS SUPERDIP SCALE
STATE DIVISIONS
170
150
130
C'
D'
GEOLOGIC SECTION
FOREST HILL
3100
3000
2900
2800
2700
2600
C"
D"
ELEVATION
Surface
Capping
Blue Gravel Channel
Bed Rock

FIG. 2. Showing a magnetic profile across the auriferous Blue Gravel Channel at Forest Hill, and a plan view and geologic section of this ancient channel deposit. It is significant that the well-defined 'low' in the magnetic profile occurs directly above this river channel. The geologic data in this figure are taken from the map of the Forest Hill Divide accompanying the Tenth Annual Report of the State Mineralogist.

Interpretation of Results

A basic principle controlling the usefulness of magnetic surveying in this type of prospecting has been well stated by C. A. Heiland: "For the application of magnetic methods to the exploration of placer ground success can be predicted only if the placer carries *less* magnetite or *more* magnetite than the country rock.'"[4] A study of the local stratigraphy in connection with the magnetic data presented above leads to the conclusion that these channel gravels and the cap rock are less magnetic (have a lower magnetic permeability) than the underlying metamorphic and igneous rocks. Thus the magnetic profiles reveal a decreased intensity, or magnetic 'low,' over those sections of a line of traverse in which the bedrock is the most deeply buried, as in the center of a large channel. The rather uniform results obtained above the Blue Gravel Channel on the Forest Hill Divide appear to confirm this interpretation. Stated otherwise, the magnetic profiles obtained at Forest Hill appear to reflect the profile of the bedrock itself. In 1926 Heiland concluded[5] that somewhat similar magnetic minima were found by K. C. Laylander[6] over less-deeply buried, gold-bearing channel deposits at Keithley and Cedar Creeks, British Columbia.

The commonly accepted belief that concealed channel deposits will always be detected in magnetic profiles by rather pronounced magnetic maxima, or 'highs,' due to concentrations of magnetic minerals in such deposits, is seen to have important exceptions. A proper interpretation of the data obtained with the magnetometer can be made only after a thorough study has been made of all geologic factors concerned. Where channel deposits have but a slight depth of cover, and where the bedrock is virtually nonmagnetic, their presence may be detected in the magnetic profiles by magnetic 'highs.' The results of the present survey tend to show that in detecting the presence of relatively-deeply buried channel deposits, the possible presence of local concentrations of magnetic minerals in the channel itself is a factor which may be less important than others, such as the magnetic permeabilities of both the cap rock and the bedrock, as compared with that of the channel deposit as a whole. The present investigation thus indicates that it may be possible to map buried channels by magnetic methods irrespective of their content of magnetic minerals, the surveys in such cases furnishing data on the character of the bedrock topography. Arthur Gibson likewise states that he has "* * * obtained good results by magnetometric surveys of placer deposits, and where there was no evidence of the presence of any magnetic (attractile) minerals."[7] In such cases the magnetic method is less direct, but as illustrated by the survey on the Forest Hill Divide, may prove to be highly effective in obtaining the desired results.

Conclusions relative to the general use of geomagnetic methods in the exploration for buried channel deposits

Depending upon local geologic conditions, the application of geomagnetic methods will vary:

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[4] C. A. Heiland: Prospecting with the Magnetometer. Eng. and Min. Jour. Vol. 122: 59. 1926.

[5] C. A. Heiland: *op. cit.*, 61.

[6] K. C. Laylander: *op. cit.*

[7] Arthur Gibson: The Magnetometer as an Aid in the Development of Mines. Min. and Scientific Press, Vol. 123: 437. 1921.

(1) Where there is no appreciable cover of later deposits, a geomagnetic survey can be relied upon to locate and outline those parts of river deposits in which black sand concentrations occur. While these concentrations generally will contain the highest values to be found in the deposit, the indicated presence of such a concentration is not in itself a guaranty that any gold values will be found. This is another basic principle that merits a clear understanding.

(2) Where channel deposits, such as the Tertiary river deposits of the northern Sierra Nevada, are buried under a capping of several hundred feet in thickness, the value of the geomagnetic method, as demonstrated at Forest Hill, lies not so much in the location of local areas of possible concentration as in the determination of the course of the buried channel as a whole—detecting its presence, tracing its course, and indicating its approximate width. While occasional mineral concentrations in the concealed channel deposit may be reflected in the magnetic profiles, their depth of burial will in many cases be too great to warrant their exploration except by operations designed to work the channel as a whole.

It should be pointed out that in some areas the distribution of the magnetic minerals in the cap rock is so irregular as to render this method impracticable in the tracing of underlying channels. South Table Mountain, near Oroville, California, was found by Arthur Gibson to be an example of such an area. For this and similar reasons it is very desirable that a preliminary test survey be made in the field in order to determine the application of the geomagnetic method to the area of immediate interest. Many geophysical exploration companies, including the one sponsoring the present investigation, are not only willing to conduct these test surveys at no cost to the client—except for actual expenses in the field—but ordinarily require that such preliminary surveys be made, for the protection of both their client and themselves. If this survey produces negative results, the advantage of finding this out before, rather than after money has been spent on a thorough examination of the properties in question is quite apparent.

General considerations concerning the application of geophysical methods

While in this article mention has been made of only the geomagnetic method, and while the writer is of the opinion that this is the most rapid and least expensive of all the geophysical methods of exploration, it should be pointed out that electrical methods have also been successfully applied to the problem of locating auriferous channel deposits, as recently reported by International Geophysics.[8] The electrical surveys were followed by magnetic surveys, which lent partial confirmation to the results obtained by the electrical method. The following discussion is intended to apply to other geophysical methods as well as the magnetic.

There are two distinct types of problems in which geophysical surveying can render service in the development of placer ground:

(1) In already partially developed ground it may aid in tracing auriferous channel deposits from known workings into virgin territory. As an example of a discovery of this kind, made as the result of a geo-

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[8] J. J. Jakosky and C. H. Wilson: Use of Geophysics in Placer Mining. Min. Journal, Dec. 1932.

magnetic survey, there is the report of the results of the survey of the Maxine deep gravel mine in Plumas County, California, made by Arthur Gibson in 1921. "The magnetic survey disclosed an ancient river channel containing heavy mineral concentrations, south of and close to the Maxine shaft, between 450–500 feet wide, extending from east to west, with a slight southward trend; * * *. A tunnel was driven south from the old workings, and the main channel was tapped. The values as well as the average depth proved to be a great improvement over the old workings."[9]

(2) In virgin territory geophysical surveying can be employed to advantage in the attempt to outline the most likely areas of mineral concentration. Such surveys lead the way for exploration by the customary methods of test-pitting, drilling, etc. An outstanding success in this application of geomagnetic methods was reported at Keithley Creek, British Columbia, by K. C. Laylander. In planning the development of this new placer ground Laylander states that "Pipe lines, power house, and equipment were distributed with these (geomagnetic) data as a sole guide. The placer ground has been worked this year and conforms exactly to that indicated by the magnetometer."[10] In this type of exploration problem the value of a geophysical survey lies not only in detecting the presence of any channel deposits, but in saving time and money in the subsequent testing of the most promising areas. In this connection it should be emphasized, for the protection of those most interested in the success of such adventures, that any geophysical survey is but the first step, essential as it may be, in the exploration work, and that it should always be immediately followed by the usual, and incidentally more expensive methods of mineral exploration. A favorable geophysical report should not be taken alone as proof of the value of a property, but rather as a favorable indication that deserves further investigation. Geophysical prospecting is not a substitute for the old-established methods of exploration, and the realization of this fundamental principle by prospective employers of geophysical services will not only place these methods in their proper light, but will lead the way toward a mutual understanding of the problems involved, and a fuller cooperation between the geophysicist, on the one hand, and the mining engineer or geologist, on the other.

It is perhaps well to recognize that as the surficial placer deposits become more and more worked over, and as more and more attention is directed toward the development of buried river channels, new methods of exploration must be found that are suited to the tasks at hand. The writer believes that properly supervised geophysical surveying is very much a part of the new technique in the successful exploration for those concealed deposits of gold-bearing gravel that today constitute a significant source of new gold in California.

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[9] Arthur Gibson (1922), *op. cit.*, 1069.

[10] K. C. Laylander, *op. cit.*, 326.

ADMINISTRATIVE

Walter W. Bradley, State Mineralogist

Personnel

There have been no changes of personnel during the past three months to be noted.

Changes in Report of the State Mineralogist

Following the consideration of a number of suggestions relative to form and contents of these quarterly chapters of the Report of the State Mineralogist, it will be noted that we have, beginning with this current issue, changed the title from ''Mining in California'' to ''California Journal of Mines and Geology.'' The principal reason is that such a name indicates that the publication is one of a serial group rather than a single bulletin or book. It also recognizes the important part that geology plays in the economic development of our mineral resources.

Price. The price is increased to 40 cents for single copies and to $1.50 for a year's subscription paid in advance. This is necessitated by the fact that the increase in contents, especially that resulting from the work of the geologic branch, and the maps included is costing the division approximately 40 cents per copy now to print. Under the statute, the State Mineralogist is directed to place a price on such reports approximating the cost of printing.

New Publications

"Mining in California" (quarterly), July–October, 1932, being Chapters 3 and 4 (combined) of the State Mineralogist's Report XXVIII: price 50 cents. Contains: "Mines and Mineral Resources of Ventura County"; "Report Accompanying Geologic Map of Northern Sierra Nevada"; "Notes on Occurrence and Age of Fossil Plants Found in the Auriferous Gravels of Sierra Nevada"; "Glacial and Associated Stream Deposits of the Sierra Nevada"; "Jurassic and Cretaceous Divisions in the Knoxville-Shasta Succession of California"; "Geology of a Part of the Panamint Range, California"; "Mineral Resources of a Part of the Panamint Range"; "Acquiring Mining Claims Through Tax Title"; "Biennial Report of the State Mineralogist".

Commercial Mineral Notes, Nos. 115, 116, 117, November, December, 1922, and January, 1933, respectively. These 'notes' contain the lists of 'mineral deposits wanted,' and 'mineral deposits for sale,' issued in the form of a mimeographed sheet monthly. It is mailed free to those on the mailing list for "California Journal of Mines and Geology." As an evidence of the interest in mines and mineral resources now showing considerable activity, this mimeographed 'sheet' has had to be expanded to two pages in recent months.

Mails and Files

The Division of Mines maintains, in addition to its correspondence files and the library, a mine file which includes original reports on the various mines and mineral properties of all kinds in California.

During each quarterly period there are several thousand letters received and answered at the San Francisco office alone, covering almost every phase of prospecting, mining and developing mineral deposits, reduction problems, marketing of refined products and mining law. In addition to this, hundreds of oral questions are answered daily, both at the main office and the district offices, for the many inquirers who come in for personal interviews and to consult the files and library.

MINERALS AND STATISTICS

Statistics, Museum, Laboratory

Henry H. Symons, Statistician and Curator

STATISTICS

CALIFORNIA'S MINERAL PRODUCTION IN 1932

The total value of the mineral production of California for the year 1932, just closed, is conservatively estimated by the statistical division, to have been approximately $209,725,000. This is, in part, detailed in the tabulation below, but as there are more than fifty mineral substances on California's commercial list, it is impracticable at this early date to obtain definite figures on other than the more important items. The blank report forms are being mailed to the operators in all mineral lines, and the detailed and complete report will be compiled and published later.

The estimated total of $209,725,000 is a decrease of approximately $6,239,000 from the value of 1931 production of $215,964,420. Petroleum and gold were the only major mineral substances whose output showed an increased value over the preceding year. Large decreases in values were registered by cement, miscellaneous stone, natural gas, copper, quicksilver, brick, industrial materials, and salines.

The value of the petroleum output was approximately 8.5 per cent higher, although the quantity showed a decrease of about 8,840,000 barrels in quantity from 1931. On June 26th there was an increase in the price of all the crude oils lighter than 20° B. Around 85% of the crude oil at present produced in California is above 20° B, some testing as high as 60° B, while the low grades range down to 9° B.

Receipts of bullion at the mint and smelters show an increase in the gold yield of about $886,000 compared with 1931. Small placer operations, brought about by unemployment in other industries, accounted for an increase of some $300,000 over that from the same source in 1931. The total output both of the lode mines and of the dredges showed increases. All other metals showed a decrease in production owing to the shutting down of operating properties due to the low prices of those metals.

The structural group shows a decrease brought about by a 55% decline in building permits in 52 California cities. Both the industrial and saline groups show likewise large decreases in value.

The estimated values and quantities for 1932 are as follows:

$11,700,000	gold
141,000	(500,000 fine oz.) silver
67,000	(1,100,000 lbs.) copper
61,000	(2,200,000 lbs.) lead
325,000	(5800 flasks) quicksilver
5,000	other metals
153,220,000	(179,533,000 bbls.) petroleum
11,740,000	(244,600,000 M cu. ft.) natural gas
7,808,000	(5,577,000 bbls.) cement
9,500,000	crushed rock, sand and gravel
1,800,000	brick and hollow building tile
158,000	(18,000 tons) magnesite
1,000,000	other structural materials including granite, lime, marble, etc.
4,200,000	miscellaneous industrial minerals
8,000,000	salines, including borates, potash, salt, soda, etc.
$209,725,000	

MUSEUM

The Museum of the State Division of Mines possesses an exceptionally fine collection of rocks and minerals of both economic and academic value. It ranks among the first five of such collections in North America and contains not only specimens of most of the known minerals found in California, but much valuable and interesting material from other states and foreign countries as well.

Mineral specimens suitable for exhibit purposes are solicited, and their donation will be appreciated by the State Division of Mines as well as by those who utilize the facilities of the collection.

The exhibit is daily visited by engineers, students, business men, and prospectors as well as tourists and mere sightseers. Beside its practical use in the economic development of California's mineral resources, the collection is a most valuable educational asset to the State and to San Francisco.

During 1932 there were 65,297 people who visited the Museum and Library of the Division of Mines in San Francisco. Among these there were many men who were forced by conditions to find new means of livelihood, and resorted to prospecting. They were able to observe here how all minerals, ores and rocks appear, thereby having a better knowledge of what they will find in the hills; also what minerals and rocks look like as described in various reports and books.

LABORATORY

FRANK SANBORN, Mineral Technologist

The laboratory of the Division of Mines is maintained for the purpose of identifying minerals and making qualitative analyses of rocks. These determinations and analyses are made without cost to those who seek the services of this State department. Ordinarily, a small sample weighing not over half a pound, in the lump form if possible, should be submitted with a letter stating what particular tests are desired, if there is a special reason for sending the material. Not more than three samples should be sent at one time, nor is it necessary to send more than one. Information regarding the size of the deposit and its proximity to rail transportation is useful in determining the possible value of a mineral body.

When requested, assistance in finding a market for a mineral will be given. When such help is desired, a small representative sample of the material for which a market is sought should accompany the request. The Division is often able to send a very small sample of a particular mineral for comparative purposes to any earnest prospector. Very small pieces of certain silicates, such as andalusite, have been supplied to those desiring them.

Determinations made by the Division of Mines during 1932 totaled 6248. Prospecting and exploitation of the State's mineral wealth increases as the State becomes more thickly populated. Each year new occurrences of some mineral in the State are reported and occasionally a new mineral species is found. New uses for a mineral are frequently found, and as a result stimulus is given to searching for that particular substance.

In the present economic distress many are seeking through hand methods of placer mining the wherewithal to purchase even food for themselves. Besides some 10,000 separate pieces of printed matter covering such information supplied through the offices of the Divsion of Mines, a total of 1200 persons were taught and had demonstrated the rudiments of placering last year in the laboratory of the Division in San Francisco.

LIBRARY

HERBERT A. FRANKE, Librarian

In addition to the numerous standard works, authoritative information on many phases of the mining and mineral industry is constantly being issued in the form of reports and bulletins by various government agencies.

The library of the Division of Mines contains some six thousand selected volumes on mines, mining and allied subjects, and it is also a repository for reports and bulletins of the technical departments of federal and State governments and of educational institutions, both domestic and foreign.

It is not the dearth of the latter publications, but rather a lack of knowledge of just what has been published and where the reports may be consulted or obtained, that embarrasses the ordinary person seeking specific information.

To assist in making the public acquainted with this valuable source of current technical information, MINING IN CALIFORNIA contains under this heading a list of all books and official reports and bulletins received, with names of publishers or issuing departments.

Files of all the leading technical journals will be found in the library, and county and State maps, topographical sheets and geological folios. Current copies of local newspapers published in the mining centers of the State are available for reference.

The library and reading room are open to the public during the usual office hours, when the librarian may be freely called upon for all necessary assistance.

OFFICIAL PUBLICATIONS RECEIVED

Government, National

U. S. Geological Survey:

Bulletins:

- 829 —Geology and Coal, Oil, and Gas Resources of the New Kensington Quadrangle, Pennsylvania. By G. B. Richardson.
- 831-B—The Ashland Coal Field, Rosebud Powder River, and Custer Counties, Montana. By N. W. Bass.
- 835 —Geology and Oil Resources of the Elk Hills, California. By Woodring, Roundy & Farnsworth.
- 836-E—The Tatonduk—Nation District, Alaska. By J. B. Mertie, Jr.
- 837 —Tertiary and Quaternary Geology of the Lower Rio Grande Region, Texas. By A. C. Trowbridge.
- 839 —Geology of the Boston Area, Massachusetts. By L. LaForge.

Professional Papers:

- 161 —Quaternary Geology of Minnesota and Parts of Adjacent States. By F. Leverett.
- 166 —Physiography and Quaternary Geology of the San Juan Mountains, Colorado. By Atwood and Mather.
- 167 —Lower Triassic Ammonoids of North America. By J. P. Smith.

170-E—The Geologic Importance of the Time-Secreting Algae with a Description of a New Travertine-Forming Organism. By M. A. Howe.
171 —Geology and Ore Deposits of the Pioche District, Nevada. By L. G. Westgate & A. Knapp.
173 —Geology and Ore Deposits of the Stockton and Fairfield Quadrangles, Utah. By James Gillney.
174 —Physiography and Glacial Geology of Eastern Montana and Adjacent Areas. By W. C. Alden.

Water Supply Papers:

638 —Contributions to the Hydrology of the U. S., 1931.
640 —Ground Water in North-Central Tennessee. By A. M. Piper.
659-A—A Method of Estimating Ground-Water Supplies Based on Discharge by Plants and Evaporation from Soil. By W. N. White.
659-B—Geology and Ground-Water Resources of the Dalles Region, Oregon. By A. M. Piper.
659-C—Index of Analyses of Natural Waters in the U. S., 1926 to 1931. By Collins & Howard.
695 —Surface Water Supply of Hawaii.
697 —Part II—South Atlantic Slope and Eastern Gulf of Mexico Basins.
698 —Part III—Ohio River Basin.
700 —Part V—Hudson Bay and Upper Mississippi River Basins.
709 —Part 12-C—Pacific Slope Basins in Oregon and Lower Columbia River Basin.
720 —Part 10—The Great Basin.

U. S. Bureau of Mines:

Bulletins:

350 —Contributions to the Data on Theoretical Metallurgy. By K. K. Kelley.
354 —The Ignition of Fire Damp by Explosives. By W. C. F. Shepherd.
355 —Coal-Mine Accidents in the U. S., 1930. By Adams, Geyer & Chenoweth.
356 —Sampling and Estimation of Ore Deposits. By C. F. Jackson and J. B. Knaebel.
357 —Shaft-Sinking Practices and Costs. By. E. D. Gardner & J. F. Johnson.
358 —Rubber-Sheathed Trailing Cables. By Ilsley, Hooker, & Coggeshall.
359 —Permissible Electric Cap Lamps & Ventilation in Certain California Mines and Water-Tunnel Construction. By S. H. Ash & J. H. Rankin.
360 —Removal of Soot from Furnaces and Flues by the Use of Salts or Compounds. By P. Nicholls and C. W. Staples.
361 —Heat Transfer from a Gas Stream to a Bed of Broken Solids. By C. C. Furnas.
362 —Metal-Mine Accidents in the U. S., 1930. By W. W. Adams.
363 —Gold-Mining and Milling in the U. S. and Canada. By Jackson and Knaebel.
364 —Clinker Formation as Related to the Fusibility of Coal Ash. By Nicholls, Selvig, & Ricketts.
365 —Laboratory Testing of the Inflammability of Coal and Other Dusts Conducted by the Bureau of Mines. By H. P. Greenwald.
366 —Quarry Accidents in the U. S. During the Calendar year 1930. By W. W. Adams.
367 —Petroleum Refinery Statistics, 1930. By G. R. Hopkins.

Economic Papers:

13 —Summarized Data on Tin Production. By J. B. Umhan.
14 —Consumption of Silver in the Arts and Industries of the U. S. By C. W. Merrill.

Technical Papers:

512 —Friability, Slacking Characteristics, Low-Temperature, Carbonization Assay and Agglutinating Value of Washington and Other Coals. By Yancey, Johnson & Silvig.

515 —Safety Organizations at Lake Superior Iron Mines. By F. S. Crawford.
519 —Carbonizing Properties and Constitution of Washed and Unwashed Coal from Mary Lee Bed, Flat Top, Jefferson Co., Alabama.
521 —Oil Prospecting in Kentucky by Resistivity Methods. By J. H. Swartz.
522 —Falls of Roof and Coal in Mines Operating in the Pittsburgh Coal Bed in Marin and Monongalia Counties, W. Va. By J. W. Paul & J. N. Geyer.
523 —A Study of High-Manganese Slags in Relation to the Treatment of Low-Grade Manganiferous Ores. By Herty, Conley, and Royer.
524 —Carbonizing Properties and Constitution of No. 6 Bed Coal from West Frankfort, Franklin County, Ill.
525 —Carbonizing Properties and Constitution of Pittsburgh Bed Coal from Edenborn Mine, Fayette County, Pa.
526 —Coke-Oven Accidents in the U. S., 1931. By Adams & Chenoweth.
528 —A Magnetic Study of Some Iron Deposits. By E. F. Stratton and J. W. Joyce.
529 —Analyses of Montana Coals. By C. E. Dobbin.
530 —Accidents at Metallurgical Works in the U. S. During the Calendar Year 1930. By W. W. Adams.
531 —Carbonizing Properties and Constitution of Black Creek Bed Coal from Empire Mine, Walker County, Ala.
534 —Falls of Roof and Coal in the Pittsburgh Coal Bed, Panhandle District, W. Virginia. By Paul & Geyer.
535 —Crater Wells, Richland Gas Field, Louisiana. By H. B. Hill.
536 —Pneumatic Tabling of Coal. By Yancey & Porter.
538 —A Survey of the High-Sulphur Crude Oils (Black Oils) Produced in Wyoming. By Thorne & Murphy.
540 —Production of Explosives in the U. S., 1931. By Adams & Gerry.
541 —A Study of Mine Roof of the Pittsburgh Coal Bed in the Pittsburgh Mining District. By Paul & Plein.
543 —Comparison of Small and Large Scale Experimental Carbonizing Apparatus.

Report of Investigations:

3172—Inflammability of Mixed Gases: Mixtures of Methane, Ethane, Hydrogen, and Nitrogen. By G. W. Jones and R. E. Kennedy.
3176—The National Safety Competition of 1931. By W. W. Adams.
3179—Do Fuses Protect Against Methane Ignitions? By A. B. Hooker, and E. J. Coggeshall.
3180—Analyses of Crude Oils from the Oklahoma City Field, Oklahoma. By E. L. Garton.
3181—Active List of Permissible Explosives and Blasting Devices Approved Prior to June 30, 1932. By Scott Turner.
3182—Review of Fatalities in the California Petroleum Industry During the Calendar Year 1931. By R. L. Marek.
3183—Smelting in the Lead Blast Furnace—Handling Rich Charges. (X)—Preparation of the Charge. By G. L. Oldright and Virgil Miller.
3184—Sanitary Surveys of the Coal-Mining Metal-Mining, and Smelter Towns of Utah. By Arthur L. Murray.
3185—Toxicity of Dichlorotetrafluoroethane. By W. P. Yant, H. H. Schrenk and F. A. Patty.
3186—Sand-and-Gravel Safety Contest of 1931. By W. W. Adams.
3187—Protection against Mercury Vapor Afforded by Canister Gas Masks. By W. P. Yant and C. E. Traubert.
3188—A Study of Falls of Roof and Coal in Mines of Lincoln County, Wyoming. By H. Tomlinson.
3189—Falls of Roof and Coal in the Book Cliffs and Wasatch Plateau Coal Fields of Utah. By Herbert Tomlinson.
3190—Economics of Potash Recovery from Wyomingite and Alunite. By J. R. Thoenen.
3191—The Effect of the Crimped-Paper Ends on Cartridges of Permissible Explosives in Propagating Detonation. By D. B. Gawthrop.

3192—Investigations During 1931 of Gases in Manholes in Boston, Mass. By G. W. Jones.
3193—Character of Drainage from Mines in the Thick Freeport Coal Bed, Pennsylvania. By R. D. Leitch, W. P. Yant, and R. R. Sayers.
3196—Compressed Air for Operating Modern Coal-Mining Equipment. By R. D. Currie.
3197—Composition of the Fractions of Primary and High-Temperature Tar. By E. B. Kester and W. D. Pohle.
3198—Survey of Fuel Consumption at Refineries in 1931. From U. S. Bureau of Mines Report 3198.

Information Circulars:

6609—Quarrying and Crushing Methods and Costs at the Santa Catalina Island Quarry of Graham Bros., Inc., Santa Catalina Island, Cal. By Geo. Adams Roalfe.
6615—Methods and Costs of Mining and Crushing Gypsum at the Mine of the Blue Diamond Corp., Ltd., Arden, Nevada. By W. G. Bradley.
6616—Mica-Mining Methods, Costs, and Recoveries at No. 10 and No. 21 Mines of the Spruce Pine Mica Co., Spruce Pine, N. C. By H. M. Urban.
6624—Magnetic Concentration Methods and Costs of Witherbee, Sherman & Co., Mineville, N. Y. By T. F. Myners.
6626—Method and Cost of Dredging Sand and Gravel, Portland Gravel Co., Portland, Ore. By Howard F. Puariea.
6630—Mining Laws of the Republic of Liberia. By E. P. Youngman.
6631—Mining Laws of Denmark and Danish Possessions. By E. P. Youngman.
6632—Mining Laws of Haiti. By E. P. Youngman.
6633—Mining Laws of the Unfederated Malay States. By E. P. Youngman.
6634—Mining Laws of Greece. By E. P. Youngman.
6635—Natural Gasoline Plants in the U. S., January 1, 1931. By G. R. Hopkins and E. M. Seeley.
6636—Mining Laws of Finland. By E. P. Youngman.
6637—Research Activities in the Mineral Industries of the United States. By A. C. Fieldner and Alden H. Emery.
6637-A—Addenda.
6638—Geophysical Abstracts No. XXXVIII. By Frederick W. Lee.
6639—Economic Factors Influencing the Domestic Demand for Gasoline. Part I—Revenue Motor Buses. By H. A. Breakey and E. B. Swanson.
6640—Shaft Sinking at the Morton Salt Co. Mine at Grand Saline, Texas. By M. Taylor.
6641—Petroleum Refineries in the U. S., January 1, 1932. By G. R. Hopkins and E. W. Cochrane.
6642—Mining Laws of Newfoundland. By E. P. Youngman.
6645—Physiological Factors in Mine Ventilation in 1931. By R. R. Sayers.
6646—Geophysical Abstracts No. XXXIX. By F. W. Lee.
6647—Silver Consumption in the Arts and Industries of the U. S. in 1930 and 1931. By Chas. White Merrill.
6648—Survey of Cracking Plants, January 1, 1932. By G. R. Hopkins.
6649—Mining and Technology Graduates and their Problems. By Scott Turner.
6650—Management of Labor in Successful Metal-Mine Operations. By Chas. Will Wright.
6651—Abstracts of Recent Articles on Mine Support. By W. R. Crane.
6652—Mining Methods and Costs at the Hart Spur Pit of the Fort Worth Sand and Gravel Co. (Inc.), Fort Worth, Texas. By Thomas E. Popplewell.
6653—Mining Statutes of the State of Pennsylvania (Summarized). By J. A. Huff and V. V. Baker.
6654—Mining Laws of Norway. By E. P. Youngman.
6655—Geophysical Abstracts No. XL. By Frederick W. Lee.
6656—Mining Methods and Costs at the Interstate Zinc and Lead Co.'s Hartley Mine, Tri-State Zinc and Lead District. By Carl N. Anderson.

6657—Clay Mining Methods and Costs at the Corunna (Mich.) Pit of the Aetna Portland Cement Co. By Oliver A. Dibble.
6658—Milling Methods and Costs at a Flat River (Mo.) Mill. By Will H. Coghill and R. G. O'Meara.
6659—Methods and Costs of Dredging Auriferous Gravels at Lancha Plana, Amador County, Cal. By Chas. G. Patmon.
6661—Mining Methods and Costs at Fresnillo, Zacatecas, Mexico. By A. Livingston.
6663—Pressure Losses Due to Bends and Area Changes in Mine Airways. By G. E. McElroy.
6665—The Significance of the Bureau of Mines Approval of Gas Masks. U. S. Bureau of Mines Info. Circular 6665
6666—Mining Methods and Costs at the New Cornelia Branch, Phelps Dodge Corp., Ajo, Arizona. By Geo. R. Ingham and Alfred T. Barr.
6667—Radium in Medical Use in the U. S. By R. R. Sayers.
6669—Geophysical Abstracts No. XLI. By Frederick W. Lee.

Mineral Resources of the United States:
Abrasive Materials in 1931.
Antimony in 1931.
Arsenic, Bismuth, Selenium, and Tellurium in 1931.
Asbestos in 1931.
Bauxite and Aluminum in 1931.
Carbon Black in 1931.
Chromite in 1931.
Cobalt, Molybdenum, Tantalum and Titanium in 1931.
Copper in 1930.
Feldspar in 1931.
Fluorspar and Cryolite in 1931.
Fuel Briquets in 1931.
Fuller's Earth in 1931.
Gold, Silver, Copper, Lead and Zinc in Arizona in 1930.
Gold, Silver, Copper, Lead and Zinc in California and Oregon in 1930.
Gold, Silver, Copper, Lead and Zinc in Colorado in 1930.
Gold, Silver, Copper, Lead and Zinc in New Mexico and Texas in 1930.
Gold, Silver, Copper, Lead and Zinc in Utah, 1930.
Gold, Silver, Copper, and Lead in South Dakota and Wyoming in 1930.
Gold, Silver, Copper, Lead and Zinc in the Eastern States, 1931.
Gold and Silver in 1930 (General Report).
Iron Ore, Pigiron and Steel in 1931.
Lead and Zinc Pigments and Salts in 1931.
Manganese and Manganiferous Ores in 1931.
Mercury in 1931.
Mineral Production of the World, 1924–1929; a Statistical Summary. By L. M. Jones.
Ore-Concentration Statistics in 1930. By T. H. Miller and R. L. Kidd.
Petroleum in 1930.
Platinum and Allied Metals in 1931.
Potash in 1931.
Salt, Bromine, and Calcium Chloride in 1931.
Silica in 1931.
Slate in 1931.
Sulphur and Pyrites in 1931.
Talc and Soapstone in 1931.
Tungsten in 1931.
Vanadium, Uranium and Radium in 1931.

U. S. Treasury Department, Washington, D. C.:
Annual Report of the Director of the Mint.

Government, State

Arizona Bureau of Mines, Tucson:
Bulletin 106—A Geological Reconnaissance of the Tucson and Arnole Mountains. By Jenkins & Wilson.
Bulletin 120—Gold and Copper Deposits near Payson, Arizona. By Lausen & Wilson.

Bulletin 122—Quicksilver Resources of Arizona. By Lausen & Gardner.
Bulletin 123—Geology and Ore Deposits of the Courtland-Gleeson Region, Arizona. By E. D. Wilson.
Bulletin 125—The Mineral Industries of Arizona. By J. B. Tenney.
Bulletin 126—Asbestos Deposits of Arizona. By Wilson & Butler.
Bulletin 127—Manganese Ore Deposits in Arizona. By Wilson & Butler.
Bulletin 128—Field Tests for the Common Metals. By G. R. Fausett.
Bulletin 129—Second Report on the Mineral Industries of Arizona. By J. B. Tenney.
Bulletin 130—Petroleum. By Butler & Tenney.
Bulletin 131—Geology and Ore Deposits of the Oatman and Katherine Districts, Arizona. By C. Lausen.
Bulletin 132—Arizona Gold Placers and Placering. By Wilson & Tenney.
Bulletin 133—Treating Gold Ores. By T. G. Chapman.
Mining Code of the State of Arizona. By T. C. Foster, State Inspector of Mines.

Arkansas Geological Survey, Little Rock:
Information Circular 2—Cinnabar in Southwestern Arkansas. By G. C. Branner.

California State Department of Public Works, Sacramento:
"California Highways and Public Works."

California State Division of Fish and Game, San Francisco:
"California Fish and Game."

California State Library, Sacramento:
"News Notes."

Colorado Bureau of Mines, Denver:
Annual Reports.

Florida State Geological Survey, Tallahassee:
Bulletin 8—Miocene Pelecypods of the Choctawhatchee Formation of Florida. By W. C. Mansfield.

Idaho Bureau of Mines and Geology, Moscow:
Pamphlet No. 36—Prospecting for Gold Ores. By J. W. Finch.

Idaho Inspector of Mines, Boise:
Annual Reports.

Illinois Geological Survey, Urbana:
P. B. No. 24—Structure and Oil Possibilities of the Warsaw Area, Hancock Co., Ill. By A. H. Bell.

Indiana Geological Survey, Indianapolis:
Geological Map of Indiana.

Kansas State Geological Survey, Lawrence:
Oil and Gas Fields of Kansas. By K. K. Landes.
Vol. XX No. 20—Grasses and Other Plants from the Tertiary Rocks of Kansas and Colorado. By M. K. Elias.
Vol. XX No. 21—Pliocene Diatoms of Wallace County, Kansas. By G. D. Hanna.

Louisiana Bureau of Scientific Research and Statistics, Minerals Section, New Orleans:
Bulletin No. 1—Geology of Iberia Parish. By Howe and Moresi.
Bulletin No. 2—Foraminifera of the Jackson Eocene at Danville Landing on the Ouachita, Catahoula Parish, La. By Howe & Wallace.

Maine Geological Survey, Augusta:
State Geologist's Report on the Geology of Maine, 1930–1932.

Michigan College of Mining and Technology, Houghton:
Prospecting and Exploration. By R. C. Matson.

Minnesota School of Mines, Minneapolis:
Mining Directory of Minnesota, 1932. By J. J. Craig.

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Memoir No. 5—Placer Mining Possibilities in Montana. By O. A. Dingman.

Nebraska Geological Survey, Lincoln:
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Nevada Inspector of Mines, Carson City:
Report for the Period Dec. 1, 1930, to June 30, 1932, incl. By A. J. Stinson.

Nevada State Bureau of Mines, Reno:
Vol. XXVI, No. 5—The Mines and Mills of Silver City, Nevada. By A. M. Smith.
Vol. XXVI, No. 7—Nonmetallic Minerals in Nevada. By J. A. Fulton and A. M. Smith.

New Jersey Dept. of Conservation and Development, Trenton:
Bulletin 38—Ground Water Supplies of the Passaic River Valley near Chatham, N. J. By D. G. Thompson.
Bulletin 39—Ground Water Supplies of the Camden Area, New Jersey. By D. G. Thompson.

New Mexico State Bureau of Mines and Mineral Resources, Socorro:
Bulletin 8—The Ore Deposits of Socorro County, New Mexico. By S. G. Lasky.

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Oklahoma Geological Survey, Norman:
Bulletin 56—The Miami-Picker Zinc-Lead District, Oklahoma. By S. Weidman.

Pennsylvania Department of Internal Affairs:
Map of Oil and Gas Fields of Western Pennsylvania. By J. D. Sisler.

Pennsylvania Geological Survey, Harrisburg:
Fourth Series, Bulletin C 1—Geology and Mineral Resources of Adams County, Penn. By G. W. Stose.
Bulletin M 6—Bituminous Coal Fields of Pennsylvania. By J. D. Sisler.
Bulletin C 2—Geology and Mineral Resources of Greene County, Penn. By R. W. Stone.
Bulletin G 2, 3, 4, 5—Meteorites, Caves, Devonian Faunas, Ordovician Limestone at Salona. By Stone, Willard and Whitcomb.
Bulletin M 15—Building Stones of Pennsylvania. By R. W. Stone.

Pennsylvania Topographic and Geologic Survey:
Geologic Map.

South Dakota State Geological Survey:
Geologic Map.
R. I. No. 12—Slacking Properties of South Dakota Coals. By W. V. Searight.

Tennessee State Division of Geology, Nashville:
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Texas Bureau of Economic Geology, Austin:
No. 3101—Contributions to Geology, 1931.
No. 3138—Underground Waters and Subsurface Temperatures of the Woodbine Sand in Northeast Texas. By F. B. Plummer and E. C. Sargent.

Virginia Geological Survey, University:
Bull. 33—Pegmatite Deposits of Virginia. By A. A. Pegan.
Bull. 36—Thermal Springs of Virginia. By F. Reeves.
Bull. 37—The Lower York—James Peninsula. By J. K. Roberts.

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  Annual Reports, Mining Reviews, etc.

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  Annual Report, 1931.
  Summary and Review of the Mineral Industry of B. C. for the Six Months Ended June 30, 1932.
  Bulletin No. 1—Lode-Gold Deposits of B. C. By J. D. Galloway.
  Bulletin No. 2—Report on McConnell Creek Placer Area, Ormineca Mining Division. By D. Fay.
  Bulletin No. 3—Lode-gold Developments in British Columbia During 1932.

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  No. 69—Methods of Collecting and Preserving Vertebrate Animals. By R. M. Anderson.
  No. 70—Annual Report for 1931.
  No. 727—Investigations of Mineral Resources and the Mining Industry, 1931.
  No. 730—Gold in Canada. By A. H. A. Robinson.
  No. 731—Feldspar. By H. S. Spence.
  No. 2260—General Index to Memoirs, Bulletins, Summary Reports and Sessional Papers. By F. Nicolas.
  No. 2314—Rare-element Minerals of Canada. By H. V. Ellsworth.
  No. 2317—Manganese Deposits of Canada. By G. Hanson.

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  Boletin Minero.
  Boletin del Petroleo.

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  Annual Reports.

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Queensland Department of Mines, Brisbane, Australia:
  Annual Reports.

Instituto Historica e Geographico, Brasileiro, Rio de Janeiro:
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New South Wales Department of Mines, Sydney, Australia:
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  Memoiras.

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Commonwealth Club, San Francisco:
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Vol. VII, No. 7—
Vol. VII, No. 8—The Eocene Sierra Blanca Limestone at the Type Locality in Santa Barbara Co., Calif. By M. F. Keenan.
Vol. VII, No. 9—A new Cardita from the Aleutian Islands and a New Epitonium from Southern California. By G. Willett.
Vol. VII, No. 10—Fossil Corals of the Genus Turbinolia from the Eocene of California. By E. H. Quayle.
Vol. VII, Nos. 11, 12, 13, 14, 15, 16, 17.

Seismological Society of America, Stanford University:
Bulletins.

Sierra Club, San Francisco:
Bulletin.

Society of Economic Paleontologists and Mineralogists, Ft. Worth, Texas:
"Journal of Paleontology."

Southern California Academy of Sciences, Los Angeles:
Bulletins.

Stanford University, California:
Abstracts of Dissertations.

Texas Technological College, Lubbock:
Bulletins.

University of California, Berkeley:

Publications in Geology:
Vol. 22, No. 2—A Skeleton of Merycoidodon Gracilis and Its Adaptive Significance. By W. D. Matthew.

Publications in Geography:
Vol. 6, No. 2—Land Forms of San Gorgonio Pass, Southern California. By R. J. Russell.
Vol. 6, No. 3—The German Colonization of Anaheim, Calif. By H. F. Raup.

Washington University, St. Louis:
Contributions in Geology and Geography.

Western Society of Engineers, Evanston, Ill.:
Journals.

Books:

A Forty-Niner Speaks. By S. W. Meyer.
Handbook of Chemistry and Physics. By Hodgman and Lange.
The Mineral Industry during 1931.
The A. B. C. of Gold Hunting. By W. Pefley.
Poorman's Modern Gold Mining and Prospecting Methods. By R. M. Perry.
Geophysical Prospecting, 1932. Transactions of the American Institute of Mining and Metallurgical Engineers.
Recent Developments in Flotation and Cyanidation of Precious Metal Ores. By Tucker and Swainson of American Cyanamid Co.
Glacial Features of Jackson Hole, Wyoming. By F. M. Fryxell.
Hoover and His Times. By Edwin Emerson.
Annual Report of the Smithsonian Institution, 1931.
On the Course of Crystallization of Pyroxenes from Rock-Magmas. By S. Tsuboi.

Mineralization Sequence in the Formation of the Gold-Silver Veins of the Toi Mine, Idza Province. By T. Kato.
Man and Metals. By T. A. Rickard.
Mining Directory—Catalog and Engineers Handbook, Los Angeles County. By Los Angeles Chamber of Commerce.
Ground Resistance Testing. By J. G. Biddle Co., Philadelphia, Pa.
Economics for Engineers. By Bowers and Rowntree.

John Hays Hammond Public Mining Library:

Petrography and Petrology. By F. F. Grout.
A Primer of Money. By Woodward and Rose.
The Teton Peaks and Their Ascents. By F. Fryxell.
A History of American Mining. By T. A. Rickard.
Choice of Methods in Mining and Metallurgy.
Technical Writing. By T. A. Rickard.
Mineral Economics. By Brookings Lectures.
Examination of Prospects. By C. G. Gunther.

Maps:

U. S. Geological Survey Topographic Maps:

California:

Adobe Quadrangle, Los Angeles County.
Angle Quadrangle, Los Angeles County.
Antelope Plain Quadrangle, Kern County.
Barstow Quadrangle, San Bernardino County.
Bena Quadrangle, Kern County.
Buttonwillow Quadrangle, Kern County.
Castaic Quadrangle, Los Angeles County.
Coal Oil Canyon Quadrangle, Kern County.
Del Sur Quadrangle, Los Angeles County.
Dry Canyon Quadrangle, Los Angeles County.
Dume Point Quadrangle. Los Angeles County.
Dunsmuir Quadrangle, Los Angeles County.
Esperanza School Quadrangle, Los Angeles County.
Etna Quadrangle, Los Angeles County.
Fairfax School Quadrangle, Kern County.
Harvester Quadrangle, Kings County.
Hayes Ranch Quadrangle, Kern County.
Hi Vista Quadrangle, Los Angeles County.
Little Buttes Quadrangle, Los Angeles County.
Lockern Quadrangle, Kern County.
Moon Mountain Quadrangle, Los Angeles County.
Mouth of Kern Quadrangle, Kern County.
Oak Flat Quadrangle, Los Angeles County.
Pentland Junction Quadrangle, Kern County.
Red Mountain Quadrangle, Los Angeles County.
Redrock Mountain Quadrangle, Los Angeles County.
Santa Felicia Canyon Quadrangle, Los Angeles County.
Solstice Canyon Quadrangle, Los Angeles County.
Stevens Quadrangle, Kern County.
Tejon Hills Quadrangle, Kern County.
Warm Spring Quadrangle, Los Angeles County.
West Camp Quadrangle, Los Angeles County.
West of Goose Lake Quadrangle, Kern County.
West of Tejon Hills Quadrangle, Kern County.
Whitaker Peak Quadrangle, Los Angeles County.
Zelzah Quadrangle, Los Angeles County.

Minnesota:

Juneberry Quadrangle.

New Mexico:

Kirtland Quadrangle, San Juan County.

North Dakota:
- Grahams Island Quadrangle.

Oklahoma:
- Yuba Quadrangle.

Texas:
- Algoa Quadrangle.
- Combes Quadrangle.
- Dickinson Quadrangle.
- Genoa Quadrangle.
- Hitchcock Quadrangle.
- Marble Falls Quadrangle.
- Mustang Bayou Quadrangle.
- Rio Hondo Quadrangle.
- Texas City Quadrangle.
- Vivian Quadrangle.

Current Magazines on File

For the convenience of persons wishing to consult the technical magazines in the reading room, a list of those on file is appended:

Architect and Engineer, San Francisco.
Asbestos, Philadelphia, Pennsylvania.
Asbestology, Canadian Asbestos Co., Montreal, Canada.
Brick and Clay Record, Chicago.
California Mining Journal, Auburn.
California Oil World, Los Angeles.
California Safety News, San Francisco.
Canadian Mining Journal, Gardenvale, Quebec.
Chemical and Metallurgical Engineering, New York City.
Chemical Engineering and Mining Review, Melbourne, Australia.
Commerce Reports, Washington, D. C.
Commonwealth, San Francisco.
Colorado School of Mines, Golden, Colorado.
Engineering and Mining Journal, New York City.
Fuel Oil, Chicago, Illinois.
Fusion Facts, Whittier, California.
Grizzly Bear, Los Angeles.
Hercules Mixer, Wilmington, Delaware.
Independent Monthly, Tulsa, Oklahoma.
Industrial Employment Information Bulletin, Washington, D. C.
Lubrication, The Texas Co., New York City.
Metals and Alloys, Pittsburgh, Pa.
Mining Congress Journal, Washington, D. C.
Mining and Industrial Record, Vancouver, B. C.
Mining Journal, London.
Mining Journal, Phoenix, Arizona.
Mining and Metallurgy, New York City.
Mining Review, Salt Lake City.
Mining Truth, Spokane, Washington.
Monthly Review of Business Conditions, San Francisco.
National Sand and Gravel, Washington, D. C.
Nickel Cast Iron News, New York City.
Oil and Gas Journal, Tulsa, Oklahoma.
Oil, Paint and Drug Reporter, New York City.
Oil Weekly, Houston, Texas.
Pit and Quarry, Chicago.
Pacific Purchaser, San Francisco.
Petroleum World, Los Angeles.
Queensland Government Mining Journal, Brisbane, Australia.
Rock Products, Chicago.
Rocks and Minerals, Peekskill, New York.
San Francisco Mining News.

Scientific American, New York City.
Southwest Builder and Contractor, Los Angeles.
Stabilizer, Los Angeles.
Standard Oil Bulletin, San Francisco.
Stone, New York City.

Newspapers

The following papers are received and kept on file in the library:

Amador Dispatch, Jackson, California.
Barstow Printer, Barstow, California.
Beaumont Gazette, Beaumont, California.
Bridgeport Chronicle-Union, Bridgeport, California.
Calaveras Californian, Angels Camp, California.
Calaveras Prospect, San Andreas, California.
Colusa Sun-Herald, Colusa, California.
Daily Commercial News, San Francisco, California.
Daily Midway Driller, Taft, California.
Del Norte Triplicate, Crescent City, California.
Denver Mining Record, Denver, Colorado.
Gold Miner. Los Angeles, California.
Inland Oil Index, Casper, Wyoming.
Inyo Independent, Independence, California.
Inyo Register, Bishop, California.
Las Vegas Age, Las Vegas, Nevada.
Livermore Herald, Livermore, California.
Mariposa Gazette, Mariposa, California.
Mercury Register, Oroville, California.
Mojave Miner, Kingman, Arizona.
Mojave-Randsburg Record, Mojave, California.
Morning Union, Grass Valley, California.
Mountain Messenger, Downieville, California.
National Industrial Review, San Francisco, California.
Needles Nugget, Needles, California.
Nevada City Nugget, Nevada City, California.
Oil Marketer, Bayonne, New Jersey.
Placer Herald, Auburn, California.
Plumas Independent, Quincy, California.
San Diego News, San Diego, California.
Shasta Courier, Redding, California.
Siskiyou News, Yreka, California.
Stockton Record, Stockton, California.
Tehachapi News, Tehachapi, California.
Terra Bella News, Terra Bella, California.
Tuolumne Independent, Sonora, California.
Tuolumne Prospector, Tuolumne, California.
Union Democrat, Sonora, California.
Ventura County News, Ventura, California.
Waterford News, Waterford, California.
Weekly Trinity Journal, Weaverville, California.
Western Mineral Survey, Salt Lake City, Utah.
Western Sentinel, Etna Mills, California.

PRODUCERS AND CONSUMERS

The producer and consumer of mineral products are mutually dependent upon each other for their prosperity, and one of the most direct aids rendered by the Bureau to the mining industry in the past has been that of bringing producers and consumers into direct touch with each other.

This work has been carried on largely by correspondence, supplemented by personal consultation. Lists of buyers of all the commercial minerals produced in California have been made available to producers upon request, and likewise the owners of undeveloped deposits of various minerals, and producers of them, have been made known to those looking for raw mineral products.

When the publication of MINING IN CALIFORNIA was on a monthly basis, current inquiries from buyers and sellers were summarized and lists of mineral products or deposits 'wanted' or 'for sale' included in each issue.

It is important that inquiries of this nature reach the mining public as soon as possible and in order to avoid the delay incident to the present quarterly publication of MINING IN CALIFORNIA, these lists are now issued monthly in the form of a mimeographed sheet under the title of 'Commercial Mineral Notes,' and sent to those on the mailing list of MINING IN CALIFORNIA.

EMPLOYMENT SERVICE

Following the establishment of the Mining Division branch offices in 1919, a free technical employment service was offered as a mutual aid to mine operators and technical men for the general benefit of the mineral industry.

Briefly summarized, men desiring positions are registered, the cards containing an outline of the applicant's qualifications, position wanted, salary desired, etc., and as notices of 'positions open' are received, the names and addresses of all applicants deemed qualified are sent to the prospective employer for direct negotiations.

Telephone and telegraphic communications are also given immediate attention.

Technical men, or those qualified for supervisory positions, and vacancies of like nature only, are registered, as no attempt will be made to supply common mine and mill labor.

Registration cards for the use of both prospective employers and employees may be obtained upon request, and a cordial invitation is extended to the industry to make free use of the facilities afforded. Parties interested should communicate direct with our San Francisco office.

PUBLICATIONS OF THE DIVISION OF MINES

During the past fifty-one years, in carrying out the provisions of the organic act creating the former California State Mining Bureau, there have been published many reports, bulletins and maps which go to make up a library of detailed information on the mineral industry of the State, a large part of which could not be duplicated from any other source.

One feature that has added to the popularity of the publications is that many of them have been distributed without cost to the public, and even the more elaborate ones have been sold at a price which barely covers the cost of printing.

Owing to the fact that funds for the advancing of the work of this department have often been limited, many of the reports and bulletins mentioned were printed in limited editions which are now entirely exhausted.

Copies of such publications are available, however, in the offices of the Division of Mines, in the Ferry Building, San Francisco; Bankers Building, Los Angeles; State Office Building, Sacramento; Redding; and Division of Oil and Gas, Santa Barbara; Santa Paula; Coalinga; Taft; Bakersfield. They may also be found in many public, private and technical libraries in California and other states and foreign countries.

A catalog of all publications from 1880 to 1917, giving a synopsis of their contents, is issued as Bulletin No. 77.

Publications in stock may be obtained by addressing any of the above offices and enclosing the requisite amount in the case of publications that have a list price. Only coin, stamps or money orders should be sent, and it will be appreciated if remittance is made in this manner rather than by personal check.

The prices noted include delivery charges to all parts of the United States. Money orders should be made payable to the Division of Mines.

NOTE.—The Division of Mines frequently receives requests for some of the early Reports and Bulletins now out of print, and it will be appreciated if parties having such publications and wishing to dispose of them will advise this office.

REPORTS

Asterisks (**) indicate the publication is out of print.

	Price
**First Annual Report of the State Mineralogist, 1880, 43 pp. Henry G. Hanks	----
**Second Annual Report of the State Mineralogist, 1882, 514 pp., 4 illustrations, 1 map. Henry G. Hanks	----
**Third Annual Report of the State Mineralogist, 1883, 111 pp., 21 illustrations. Henry G. Hanks	----
**Fourth Annual Report of the State Mineralogist, 1884, 410 pp., 7 illustrations. Henry G. Hanks	----
**Fifth Annual Report of the State Mineralogist, 1885, 234 pp., 15 illustrations, 1 geological map. Henry G. Hanks	----
**Sixth Annual Report of the State Mineralogist, Part I, 1886, 145 pp., 3 illustrations, 1 map. Henry G. Hanks	----
**Part II, 1887, 222 pp., 36 illustrations. William Irelan, Jr.	----

REPORTS—Continued

Asterisks (**) indicate the publication is out of print.

	Price
**Seventh Annual Report of the State Mineralogist, 1887, 315 pp. William Irelan, Jr.	----
**Eighth Annual Report of the State Mineralogist, 1888, 948 pp., 122 illustrations. William Irelan, Jr.	----
**Ninth Annual Report of the State Mineralogist, 1889, 352 pp., 57 illustrations, 2 maps. William Irelan, Jr.	----
**Tenth Annual Report of the State Mineralogist, 1890, 983 pp., 179 illustrations, 10 maps. William Irelan, Jr.	----
Eleventh Report (First Biennial) of the State Mineralogist, for the two years ending September 15, 1892, 612 pp., 73 illustrations, 4 maps. William Irelan, Jr.	$1.00
**Twelfth Report (Second Biennial) of the State Mineralogist, for the two years ending September 15, 1894, 541 pp., 101 illustrations, 5 maps. J. J. Crawford	----
**Thirteenth Report (Third Biennial) of the State Mineralogist, for the two years ending September 15, 1896, 726 pp., 93 illustrations, 1 map. J. J. Crawford	----
Chapters of the State Mineralogist's Report, Biennial Period, 1913–1914, Fletcher Hamilton:	
**Mines and Mineral Resources, Amador, Calaveras and Tuolumne Counties, 172 pp., paper	----
Mines and Mineral Resources, Colusa, Glenn, Lake, Marin, Napa, Solano, Sonoma and Yolo Counties, 208 pp., paper	.50
**Mines and Mineral Resources, Del Norte, Humboldt and Mendocino Counties, 59 pp., paper	----
**Mines and Mineral Resources, Fresno, Kern, Kings, Madera, Mariposa, Merced, San Joaquin and Stanislaus Counties, 220 pages, paper	----
**Mines and Mineral Resources of Imperial and San Diego Counties, 113 pp., paper	----
**Mines and Mineral Resources, Shasta, Siskiyou and Trinity Counties, 180 pp., paper	----
**Fourteenth Report of the State Mineralogist, for the Biennial Period 1913–1914, Fletcher Hamilton, 1915:	—
A General Report on the Mines and Mineral Resources of Amador, Calaveras, Tuolumne, Colusa, Glenn, Lake, Marin, Napa, Solano, Sonoma, Yolo, Del Norte, Humboldt, Mendocino, Fresno, Kern, Kings, Madera, Mariposa, Merced, San Joaquin, Stanislaus, San Diego, Imperial, Shasta, Siskiyou and Trinity Counties, 974 pp., 275 illustrations, cloth	----
Chapters of the State Mineralogist's Report, Biennial Period, 1915–1916. Fletcher Hamilton:	
**Mines and Mineral Resources, Alpine, Inyo and Mono Counties, 176 pp., paper	----
Mines and Mineral Resources, Butte, Lassen, Modoc, Sutter and Tehama Counties, 91 pp., paper	.50
**Mines and Mineral Resources, El Dorado, Placer, Sacramento and Yuba Counties, 198 pp., paper	----
Mines and Mineral Resources, Monterey, San Benito, San Luis Obispo, Santa Barbara and Ventura Counties, 183 pp., paper	.65
**Mines and Mineral Resources, Los Angeles, Orange and Riverside Counties, 136 pp., paper	----
**Mines and Mineral Resources, San Bernardino and Tulare Counties, 186 pp., paper	----
**Fifteenth Report of the State Mineralogist, for the Biennial Period 1915–1916, Fletcher Hamilton, 1917:	
A General Report on the Mines and Mineral Resources of Alpine, Inyo, Mono, Butte, Lassen, Modoc, Sutter, Tehama, Placer, Sacramento, Yuba, Los Angeles, Orange, Riverside, San Benito, San Luis Obispo, Santa Barbara, Ventura, San Bernardino and Tulare Counties, 990 pp., 413 illustrations, cloth	----
Chapters of the State Mineralogist's Report, Biennial Period 1917–1918, Fletcher Hamilton:	
Mines and Mineral Rosources of Nevada County, 270 pp., paper	.75
Mines and Mineral Resources of Plumas County, 188 pp., paper	.50
Mines and Mineral Resources of Sierra County, 144 pp., paper	.50

REPORTS—Continued

Asterisks (**) indicate the publication is out of print.

	Price
Seventeenth Report of the State Mineralogist, 1920, 'Mining in California during 1920,' Fletcher Hamilton; 562 pp., 71 illustrations, cloth	$1.75
Eighteenth Report of the State Mineralogist, 1922, 'Mining in California,' Fletcher Hamilton. Chapters published monthly beginning with January, 1922:	
**January, **February, **March, **April, **May, **June, July, August, September, October, **November, December, 1922	Free
Chapters of Nineteenth Report of the State Mineralogist, 'Mining in California,' Fletcher Hamilton and Lloyd L. Root. January, February, March, September, 1923	Free
Chapters of Twentieth Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly. January, April, **July, October, 1924, per copy	.25
Chapters of Twenty-first Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly:	
January, 1925, Mines and Mineral Resources of Sacramento, Monterey and Orange Counties	.25
April, 1925, Mines and Mineral Resources of Calaveras. Merced, San Joaquin, Stanislaus and Ventura Counties	.25
July, 1925, Mines and Mineral Resources of Del Norte, Humboldt and San Diego Counties	.25
**October, 1925, Mines and Mineral Resources of Siskiyou, san Luis Obispo and Santa Barbara Counties	----
Chapters of Twenty-second Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly:	
January, 1926, Mines and Mineral Resources of Trinity and Santa Cruz Counties	.25
April, 1926, Mines and Mineral Resources of Shasta, San Benito and Imperial Counties	.25
July, 1926, Mines and Mineral Resources of Marin and Sonoma Counties	.25
October, 1926, Mines and Mineral Resources of El Dorado and Inyo Counties, also report on Minaret District, Madera County	.25
Chapters of Twenty-third Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly:	
January, 1927, Mines and Mineral Resources of Contra Costa County; Santa Catalina Island	.25
April, 1927, Mines and Mineral Resources of Amador and Solano Counties	.25
July, 1927, Mines and Mineral Resources of Placer and Los Angeles Counties	.25
October, 1927, Mines and Mineral Resources of Mono County	.25
Chapters of Twenty-fourth Report of the State Mineralogist, 'Mining in California.' Lloyd L. Root. Published quarterly:	
January, 1928, Mines and Mineral Resources of Tuolumne County	.25
April, 1928, Mines and Mineral Resources of Mariposa County	.25
**July 1928, Mines and Mineral Resources of Butte and Tehama Counties	----
October, 1928, Mines and Mineral Resources of Plumas and Madera Counties	.25
Chapters of Twenty-fifth Report of the State Mineralogist, 'Mining in California.' Walter W. Bradley. Published quarterly:	
**January, 1929, Mines and Mineral Resources of Lassen, Modoc and Kern Counties; also on Special Placer Machines	----
April, 1929, Mines and Mineral Resources of Sierra, Napa, San Francisco and San Mateo Counties	.25
July, 1929, Mines and Mineral Resources of Colusa, Fresno and Lake Counties	.25
October, 1929, Mines and Mineral Resources of Glenn, Alameda, Mendocino and Riverside Counties	.25
Chapters of Twenty-sixth Report of the State Mineralogist 'Mining in California', Walter W. Bradley. Published quarterly:	
January, 1930, Mines and Mineral Resources of Santa Clara County; also Barite in California	.25
April, 1930, Mines and Mineral Resources of Nevada County; also Mineral Paint Materials in California	.25
July, 1930, Mines and Mineral Resources of Yuba and San Bernardino Counties; also Commercial Grinding Plants in California	.25

REPORTS—Continued

Asterisks (**) indicate the publication is out of print.

	Price
October, 1930, Mines and Mineral Resources of Butte, Kings and Tulare Counties; also Geology of Southwestern Mono County (Preliminary)	$0.25
Chapters of Twenty-seventh Report of the State Mineralogist, 'Mining in California', Walter W. Bradley. Published quarterly:	
January, 1931, Preliminary Report on Economic Geology of the Shasta Quadrangle. Beryllium and Beryl. The New Tariff and Nonmetallic Products. Crystalline Talc. Decorative effects in Concrete	.25
April, 1931, Stratigraphy of the Kreyenhagen Shale. Diatoms and Silicoflagellates of the Kreyenhagen Shale. Foraminifer of the Kreyenhagen Shale. Geology of Santa Cruz Island	.25
July, 1931. (Yuba, San Bernardino.) Feldspar, Silica, Andalusite and Cyanite Deposits of California. Note on a Deposit of Andalusite in Mono County; its occurrence and chemical importance. Bill creating Trinity and Klamath River Fish and Game District and its effect upon mining	.25
October, 1931. (Alpine.) Geology of the San Jacinto Quadrangle south of San Gorgonio Pass, California. Notes on Mining Activity in Inyo and Mono Counties in July, 1931	.25
Chapters of Twenty-eighth Report of the State Mineralogist, 'Mining in California,' Walter W. Bradley. Published quarterly:	
January, 1932, Economic Mineral Deposits of the San Jacinto Quadrangle. Geology and Physical Properties of Building Stone from Carmel Valley. Contributions to the Study of Sediments. Sediments of Monterey Bay. Sanbornite	.25
April, 1932. Elementary Placer Mining Methods and Gold Saving Devices. The Pan, Rocker and Sluice Box. Prospecting for Vein Deposits. Bibliography of Placer Mining	.25
Subscription, $1.00 in advance (by calendar year, only).	
Chapters of State Oil and Gas Supervisor's Report:	
Summary of Operations—California Oil Fields, July, 1918, to March, 1919 (one volume)	Free
Summary of Operations—California Oil Fields. Published monthly, beginning April, 1919:	
**April, **May, **June, **July, **August, **September, **October, **November, **December, 1919	----
**January, **February, **March, **April, **May, **June, **July, **August, **September, **October, **November, **December, 1920	----
January, **February, **March, April, **May, **June, **July, August, **September, **October, **November, **December, 1921	Free
January, February, March, April, May, **June, **July, **August, September, **October, **November, December, 1922	Free
January, **February, **March, **April, May, **June, **July, August, September, **October, November, December, 1923	Free
January, February, March, April, May, June, July, August, September, October, November, December, 1924	Free
January, February, March, April, May, June, **July, August, September, October, November, December, 1925	Free
January, February, March, April, May, June, July, August, September, October, November, December, 1926	Free
January, February, March, April, May, June, July, August, September, October, November, December, 1927	Free
January, February, March, April, **May, June, July, **August, September, **October, **November, **December, 1928	Free
January, February, March, April, May, June, July-August-September, October-November-December, 1929	Free
January-February-March, April-May-June, July-August-September, October-November-December, 1930	Free
(Published quarterly beginning July, 1929.)	
January-February-March, April-May-June, July-August-September, 1931	Free

BULLETINS

Asterisks (**) indicate the publication is out of print.

	Price
**Bulletin No. 1. A Description of Some Desiccated Human Remains, by Winslow Anderson. 1888, 41 pp., 6 illustrations	----
**Bulletin No. 2. Methods of Mine Timbering, by W. H. Storms. 1894, 58 pp., 75 illustrations	----
**Bulletin No. 3. Gas and Petroleum Yielding Formations of Central Valley of California, by W. L. Watts. 1894, 100 pp., 13 illustrations, 4 maps	----
**Bulletin No. 4. Catalogue of Californian Fossils, by J. G. Cooper, 1894, 73 pp., 67 illustrations. (Part I was published in the Seventh Annual Report of the State Mineralogist, 1887.)	----
**Bulletin No. 5. The Cyanide Process, 1894, by Dr. A. Scheidel. 140 pp., 46 illustrations	----
**Bulletin No. 6. California Gold Mill Practices, 1895, by E. B. Preston, 85 pp., 46 illustrations	----
**Bulletin No. 7. Mineral Production of California, by Counties, for the year 1894, by Charles G. Yale. Tabulated sheet	----
**Bulletin No. 8. Mineral Production of California, by Counties, for the year 1895, by Charles G. Yale. Tabulated sheet	----
**Bulletin No. 9. Mine Drainage, Pumps, etc., by Hans C. Behr. 1896, 210 pp., 206 illustrations	----
**Bulletin No. 10. A bibliography Relating to the Geology, Paleontology and Mineral Resources of California, by Anthony W. Vogdes. 1896, 121 pp.	----
**Bulletin No. 11. Oil and Gas Yielding Formations of Los Angeles, Ventura and Santa Barbara Counties, by W. L. Watts. 1897, 94 pp., 6 maps, 31 illustrations	----
**Bulletin No. 12. Mineral Production of California, by Counties, for 1896, by Charles G. Yale. Tabulated sheet	----
**Bulletin No. 13. Mineral Production of California, by Counties, for 1897, by Charles G. Yale. Tabulated sheet	----
**Bulletin No. 14. Mineral Production of California, by Counties, for 1898, by Charles G. Yale	----
**Bulletin No. 15. Map of Oil City Fields, Fresno County, by John H. Means. 1899	----
**Bulletin No. 16. The Genesis of Petroleum and Asphaltum in California, by A. S. Cooper. 1899, 39 pp., 29 illustrations	----
**Bulletin No. 17. Mineral Production of California, by Counties, for 1899, by Charles G. Yale. Tabulated sheet	----
**Bulletin No. 18. Mother Lode Region of California, by W. H. Storms. 1900, 154 pp., 49 illustrations	----
**Bulletin No. 19. Oil and Gas Yielding Formations of California, by W. L. Watts. 1900, 236 pp., 60 illustrations. 8 maps	----
**Bulletin No. 20. Synopsis of General Report of State Mining Bureau, by W. L. Watts. 1901, 21 pp. This bulletin contains a brief statement of the progress of the mineral industry in California for the four years ending December, 1899	----
**Bulletin No. 21. Mineral Production of California by Counties, by Charles G. Yale. 1900. Tabulated sheet	----
**Bulletin No. 22. Mineral Production of California for Fourteen Years, by Charles G. Yale. 1900. Tabulated sheet	----
Bulletin No. 23. The Copper Resources of California, by P. C. DuBois, F. M. Anderson, J. H. Tibbits and G. A. Tweedy. 1902, 282 pp., 69 illustrations, 9 maps	$0.50
**Bulletin No. 24. The Saline Deposits of California, by G. E. Bailey. 1902, 216 pp., 99 illustrations, 5 maps	----
**Bulletin No. 25. Mineral Production of California, by Counties, for 1901, by Charles G. Yale. Tabulated sheet	----
**Bulletin No. 26. Mineral Production of California for the Past Fifteen Years, by Charles G. Yale. 1902. Tabulated sheet	----
**Bulletin No. 27. The Quicksilver Resources of California, by William Forstner. 1903, 273 pp., 144 illustrations, 8 maps	----
**Bulletin No. 28. Mineral Production of California for 1902, by Charles G. Yale. Tabulated sheet	----

BULLETINS—Continued

Asterisks (**) indicate the publication is out of print.

	Price
**Bulletin No. 29. Mineral Production of California for Sixteen Years, by Charles G. Yale. 1903. Tabulated sheet	----
**Bulletin No. 30. Bibliography Relating to the Geology, Paleontology and Mineral Resources of California, by A. W. Vogdes. 1903, 290 pp.	----
**Bulletin No. 31. Chemical Analyses of California Petroleum, by H. N. Cooper. 1904. Tabulated sheet	----
**Bulletin No. 32. Production and Use of Petroleum in California, by Paul W. Prutzman. 1904, 230 pp., 116 illustrations, 14 maps	----
**Bulletin No. 33. Mineral Production of California, by Counties, for 1903, by Charles G. Yale. Tabulated sheet	----
**Bulletin No. 34. Mineral Production of California for Seventeen Years, by Charles G. Yale. 1904. Tabulated sheet	----
**Bulletin No. 35. Mines and Minerals of California, by Charles G. Yale. 1904, 55 pp., 20 county maps. Relief map of California	----
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Bulletin No. 106. Manner of Locating and Holding Mineral Claims in California (with forms)	.25
Bulletin No. 107. Mineral Production in California for 1931 and Directory of Producers	Free

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**Preliminary Report No. 2. Notes on Damage by Water in California Oil Fields, March, 1914. By R. P. McLaughlin. 4 pp.	----
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**Preliminary Report No. 6. A Review of Mining in California During 1919. By Fletcher Hamilton, 1920. 43 pp. Paper	----
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**Preliminary Report No. 8. A Review of Mining in California During 1921, with Notes on the Outlook for 1922. By Fletcher Hamilton, 1922. 68 pp. Paper	----

MISCELLANEOUS PUBLICATIONS

**First Annual Catalogue of the State Museum of California, being the collection made by the State Mining Bureau during the year ending April 16, 1881. 350 pp.	----
**Catalogue of books, maps, lithographs, photographs, etc., in the library of the State Mining Bureau at San Francisco, May 15, 1884. 19 pp.	----
**Catalogue of the State Museum of California, Volume II, being the collection made by the State Mining Bureau from April 16, 1881, to May 5, 1884. 220 pp.	----
**Catalogue of the State Museum of California, Volume III, being the collection made by the State Mining Bureau from May 15, 1884, to March 31, 1887. 195 pp.	----
**Catalogue of the State Museum of California, Volume IV, being the collection made by the State Mining Bureau from March 30, 1887, to August 20, 1890. 261 pp.	----
**Catalogue of the Library of the California State Mining Bureau, September 1, 1892. 149 pp.	----
**Catalogue of West North American and Many Foreign Shells with Their Geographical Ranges, by J. G. Cooper. Printed for the State Mining Bureau, April, 1894	----
**Report of the Board of Trustees for the four years ending September, 1900. 15 pp. Paper.	----
Bulletin. Reconnaissance of the Colorado Desert Mining District. By Stephen Bowers, 1901. 19 pp. 2 illustrations. Paper.	Free
Commercial Mineral Notes. A monthly mimeographed sheet, beginning April, 1923	Free

MAPS

Register of Mines With Maps.

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	Price
Register of Mines, with Map, Amador County	$0.25
Register of Mines, with Map, Butte County	.25
**Register of Mines, with Map, Calaveras County	----
**Register of Mines, with Map, El Dorado County	----
**Register of Mines, with Map, Inyo County	----
**Register of Mines, with Map, Kern County	----
**Register of Mines, with Map, Lake County	----
**Register of Mines, with Map, Mariposa County	----
**Register of Mines, with Map, Nevada County	----
**Register of Mines, with Map, Placer County	----
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**Register of Mines, with Map, San Bernardino County	----
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Register of Mines, with Map, Santa Barbara County (1906)	.25
**Register of Mines, with Map, Shasta County	----
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**Register of Mines, with Map, Trinity County	----
**Register of Mines, with Map, Tuolumne County	----
Register of Mines, with Map, Yuba County (1905)	.25
Register of Oil Wells, with Map, Los Angeles City (1906)	.35

OTHER MAPS

**Map of California, Showing Mineral Deposits (50 x 60 in.)	----
**Map of Forest Reserves in California	----
**Mineral and Relief Map of California	----
**Map of El Dorado County, Showing Boundaries, National Forests	----
**Map of Madera County, Showing Boundaries, National Forests	----
**Map of Placer County, Showing Boundaries, National Forests	----
**Map of Shasta County, Showing Boundaries, National Forests	----
**Map of Sierra County, Showing Boundaries, National Forests	----
**Map of Siskiyou County, Showing Boundaries, National Forests	----
**Map of Tuolumne County, Showing Boundaries, National Forests	----
**Map of Mother Lode Region	----
**Map of Desert Region of Southern California	----
Map of Minaret District, Madera County	.20
Map of Copper Deposits in California	.05
**Map of Calaveras County	----
**Map of Plumas County	----
**Map of Trinity County	----
**Map of Tuolumne County	----
Geological Map of Inyo County. Scale 1 inch equals 4 miles	.60
**Map of California accompanying Bulletin No. 89, showing generalized classification of land with regard to oil possibilities. Map only, without Bulletin	----
Geological Map of California, 1916. Scale 1 inch equals 12 miles. As accurate and up-to-date as available data will permit as regards topography and geography. Shows railroads, highways, post offices and other towns. First geological map that has been available since 1892, and shows geology of entire state as no other map does. Geological details lithographed in 23 colors. Unmounted	.75
Mounted	2.00
**Topographic Map of Sierra Nevada Gold Belt, showing distribution of auriferous gravels, accompanying Bulletin No. 92 (also sold singly) In 4 colors	----
Geologic Map of Northern Sierra Nevada, showing Tertiary River Channels and Mother Lode Belt, accompanying July-October Chapter of Report XXVIII of the State Mineralogist. (Sold singly.)	.25

OIL FIELD MAPS

These maps are revised from time to time as development work advances and ownerships change.

	Price
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Map No. 2—Santa Maria, including Cat Canyon and Los Alamos	.75
Map No. 3—Santa Maria, including Casmalia and Lompoc	.75
Map No. 4—Whittier-Fullerton, including Olinda, Brea Canyon, Puente Hills, East Coyote and Richfield	.75
Map No. 5—Whittier-Fullerton, including Whittier, West Coyote and Montebello	.75
Map No. 6—Salt Lake, Los Angeles County	.75
Map No. 7—Sunset and San Emidio and Kern County	.75
Map No. 8—South Midway and Buena Vista Hills, Kern County	.75
Map No. 9—North Midway and McKittrick, Kern County	.75
Map No. 10—Belridge and McKittrick, Kern County	.75
Map No. 11—Lost Hills and North Belridge, Kern County	.75
Map No. 12—Devils Den, Kern County	.75
Map No. 13—Kern River, Kern County	.75
Map No. 14—Coalinga, Fresno County	1.00
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Map No. 16—Ventura-Ojai, Ventura County	.75
Map No. 17—Santa Paula-Sespe Oil Fields, Ventura County	.75
Map No. 18—Piru-Simi-Newhall Oil Fields	.75
Map No. 19—Arroyo Grande, San Luis Obispo County	.75
Map No. 20—Long Beach Oil Field	1.25
Map No. 21—Portion of District 4, Showing Boundaries of Oil Fields, Kern and Kings counties	.75
Map No. 21A—Portion Kern and Kings counties	.75
Map No. 22—Portion of District 3, Showing Oil Fields, Santa Barbara County	.75
Map No. 23—Portion of District 2, Showing Boundaries of Oil Fields, Ventura County	.75
Map No. 24—Portion of District 1, Showing Boundaries of Oil Fields, Los Angeles and Orange counties	.75
Map No. 26—Huntington Beach Oil Field	.75
Map No. 27—Santa Fe Springs Oil Field	.75
Map No. 28—Torrance, Los Angeles County	.75
Map No. 29—Dominguez, Los Angeles County	.75
Map No. 30—Rosecrans, Los Angeles County	.75
Map No. 31—Inglewood, Los Angeles County	.75
Map No. 32—Seal Beach, Los Angeles and Orange counties	.75
Map No. 33—Rincon, Ventura County	.75
Map No. 34—Mt. Poso, Kern County	.75
Map No. 35—Round Mountain, Kern County	.75
Map No. 36—Kettleman Hills, Kings County	1.25
Map No. 37—Montebello, Los Angeles County	.75
Map No. 38—Whittier, Los Angeles County	.75
Map No. 39—West Coyote, Los Angeles and Orange counties	.75
Map No. 40—Elwood, Santa Barbara County	.75
Map No. 41—Potrero, Los Angeles County	.75
Map No. 42—Playa Del Rey, Los Angeles County	.75
Map. No. 43—Capitan, Santa Barbara County	.75
Map No. 44—Mesa, Santa Barbara County	.75

DETERMINATION OF MINERAL SAMPLES

Samples (limited to three at one time) of any mineral found in the State may be sent to the Division of Mines for identification, and the same will be classified free of charge. No samples will be determined if received from points outside the State. It must be understood that no assays, or quantitative determinations will be made. Samples should be in lump form if possible, and marked plainly with name of sender on outside of package, etc. No samples will be received unless delivery charges are prepaid. A letter should accompany sample, giving locality where mineral was found and the nature of the information desired.

1265 6-33 2500

STATE OF CALIFORNIA
DEPARTMENT OF NATURAL RESOURCES

DIVISION OF MINES

CORDIALLY INVITES YOU TO VISIT
ITS VARIOUS DEPARTMENTS MAINTAINED
FOR THE PURPOSE OF FURTHERING
THE DEVELOPMENT OF THE

MINERAL RESOURCES OF CALIFORNIA

At the service of the public are the scientific reference library and reading room, the general information bureau, the laboratory for the free determination of mineral samples found in the State, and the largest museum of mineral specimens on the Pacific Coast. The time and attention of the State Mineralogist, as well as that of his technical staff, are also at your disposal.

Office hours: 9 a.m. to 5 p.m. daily.
Saturday, 9 a.m. to 12 m.

WALTER W. BRADLEY,
State Mineralogist.

Third floor, Ferry Building, San Francisco, Cal.
Branch Offices: Bankers Building, Los Angeles; State Office Building, Sacramento; Chamber of Commerce, Redding; Bank of Italy Building, Bakersfield; San Marcos Building, Santa Barbara; Taft, Coalinga and Santa Paula.

STATE OF CALIFORNIA
DEPARTMENT OF NATURAL RESOURCES
D. H. BLOOD, Director

DIVISION OF MINES
FERRY BUILDING, SAN FRANCISCO

WALTER W. BRADLEY State Mineralogist

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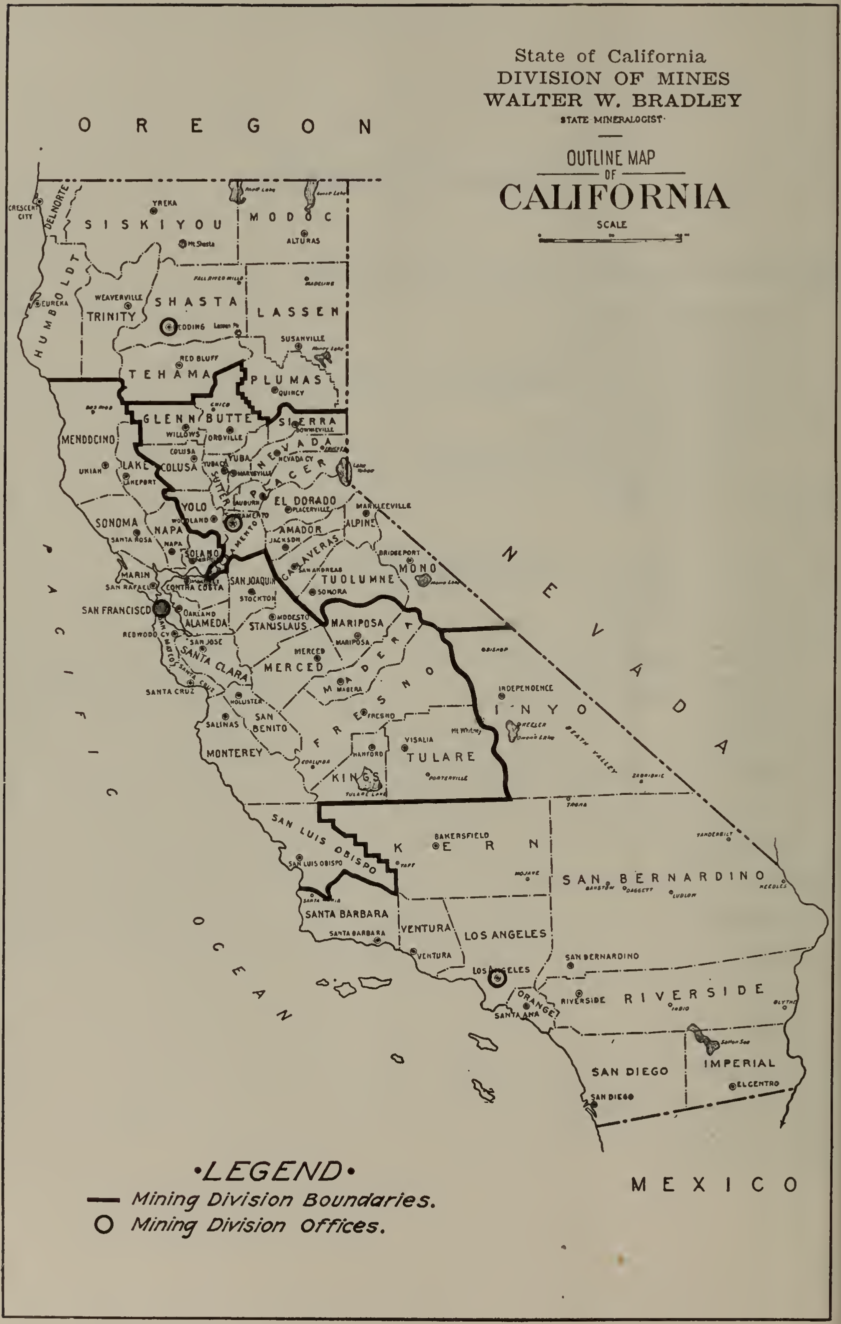

State of California
DIVISION OF MINES
WALTER W. BRADLEY
STATE MINERALOGIST

OUTLINE MAP
OF
CALIFORNIA

SCALE
OREGON
NEVADA
PACIFIC OCEAN
MEXICO
DELNORTE
CRESCENT CITY
SISKIYOU
YREKA
Mt Shasta
MODOC
ALTURAS
HUMBOLDT
EUREKA
TRINITY
WEAVERVILLE
SHASTA
REDDING
Lassen Pk
LASSEN
SUSANVILLE
TEHAMA
RED BLUFF
PLUMAS
QUINCY
GLENN
WILLOWS
BUTTE
CHICO
OROVILLE
SIERRA
DOWNIEVILLE
MENDOCINO
UKIAH
LAKE
LAKEPORT
COLUSA
YUBA
MARYSVILLE
NEVADA
NEVADA CY
PLACER
AUBURN
SUTTER
YOLO
WOODLAND
SACRAMENTO
EL DORADO
PLACERVILLE
ALPINE
MARKLEEVILLE
SONOMA
SANTA ROSA
NAPA
SOLANO
AMADOR
JACKSON
CALAVERAS
SAN ANDREAS
MONO
BRIDGEPORT
MARIN
SAN RAFAEL
CONTRA COSTA
SAN JOAQUIN
STOCKTON
TUOLUMNE
SONORA
SAN FRANCISCO
OAKLAND
ALAMEDA
MODESTO
STANISLAUS
MARIPOSA
REDWOOD CY
SAN MATEO
SAN JOSE
SANTA CLARA
MERCED
MADERA
SANTA CRUZ
HOLLISTER
SALINAS
SAN BENITO
FRESNO
INDEPENDENCE
BISHOP
INYO
Mt Whitney
DEATH VALLEY
VISALIA
TULARE
PORTERVILLE
MONTEREY
HANFORD
KINGS
COALINGA
Tulare Lake
SAN LUIS OBISPO
SAN LUIS OBISPO
BAKERSFIELD
KERN
TAFT
MOJAVE
TRONA
VANDERBILT
SAN BERNARDINO
BARSTOW
DAGGETT
LUDLOW
NEEDLES
SANTA MARIA
SANTA BARBARA
SANTA BARBARA
VENTURA
VENTURA
LOS ANGELES
LOS ANGELES
SAN BERNARDINO
RIVERSIDE
RIVERSIDE
INDIO
BLYTHE
ORANGE
SANTA ANA
Salton Sea
SAN DIEGO
SAN DIEGO
IMPERIAL
EL CENTRO
•LEGEND•
— Mining Division Boundaries.
O Mining Division Offices.

PREFACE

The Division of Mines (formerly State Mining Bureau) is maintained for the purpose of assisting in all possible ways in the development of California's mineral resources.

As one means of offering tangible service to the mining public, the State Mineralogist for many years has issued an annual or a biennial report reviewing in detail the mines and mineral deposits of the various counties.

As a progressive step in advancing the interests of the mineral industry, and as permitting earlier distribution to the public, publication of the Annual Report of the State Mineralogist in the form of monthly chapters was begun in January, 1922, and continued until March, 1923. Owing to a lack of funds for printing this was changed to a quarterly publication, beginning in September, 1923. For the same reason, beginning with the January, 1924, issue, it became necessary to charge a subscription price. This covers approximately the cost of printing.

Pages are numbered consecutively throughout the year and an index to the complete report is included annually in the closing number.

Beginning with the 1930 issues, the activities and progress of the Geologic Branch are recorded also in these quarterly chapters. The important part that geology plays in the economic development of our mineral resources is further recognized in the change of title from MINING IN CALIFORNIA to CALIFORNIA JOURNAL OF MINES AND GEOLOGY, beginning with the January, 1933, chapter.

Such a publication admits of several improvements over the former method of procedure. Reports of the current development and mining activities of the State, prepared by the district mining engineers, are given. Special articles dealing with various phases of mining and allied subjects by members of the staff and other contributors are included. Mineral production reports formerly issued only as an annual statistical bulletin are also published herein as soon as returns from producers are compiled. The executive activities, and those of the laboratory, museum, library, employment service and other features with which the public has had too little acquaintance, also are reported.

While current activities of all descriptions are covered in these chapters, the practice of issuing from time to time technical reports on special subjects will be continued as well. A list of such reports now available is appended hereto, and the names of new bulletins will be added in the future as they are completed.

The chapters are subject to revision, correction and improvement. Constructive suggestions from the mining public will be gladly received, and are invited.

The one aim of the Division of Mines is to increase its usefulness and to stimulate the intelligent development of the wonderful, latent resources of the State of California.

Types of Reports

In general the reports presented in these chapters are grouped into three classes:

1. Mines and mineral resources of a given County (describing kind, character, distribution and extent of development).
2. Specific economic and industrial mineral products (listing and describing the resources over the entire State of a given mineral substance, e.g. feldspar).
3. Geological reports on specific areas (recording results and conclusions, with maps, derived from field studies; and tied in with economic possibilities, and developments).

REPORTS OF DISTRICT MINING ENGINEERS

In 1919–1920 the Mining Bureau was organized into four main geographical divisions, with the field work delegated to a mining engineer in each district, working out from field offices that were established in Redding, Auburn, San Francisco and Los Angeles, respectively. This move brought the office into closer personal contact with operators, and it has many advantages over former methods of conducting field work, including lower traveling-expense bills for the Bureau's engineers. In 1923 the Redding and Auburn field offices were consolidated and moved to Sacramento.

The Redding office was reestablished in 1928, and the boundaries of each district adjusted. The counties now included in each of the four divisions and the locations of the branch offices are shown on the accompanying outline map of the State. (Frontispiece.)

Reports of mining activities and development in each division, prepared by the District Engineer, will continue to appear under the proper field division heading.

Although the petroleum industry is but little affiliated with other branches of mining, oil and gas are among the most valuable mineral products of California, and a report by the State Oil and Gas Supervisor on the current development and general conditions in the State's oil fields is included under this heading.

REDDING FIELD DIVISION

CHAS. V. AVERILL, Mining Engineer

Reports covering the mines and mineral resources of all of the counties in the Redding field division are now available, and field work at present is confined to investigations for special reports upon various economic minerals.

SACRAMENTO FIELD DIVISION

C. A. LOGAN, Mining Engineer

Mr. C. A. Logan, District Engineer, is engaged in the preparation of a special report upon the Mother Lode Gold Belt of California, which it is planned will be published soon.

SAN FRANCISCO FIELD DIVISION

C. McK. LAIZURE, Mining Engineer

Reports covering the mines and mineral resources of all of the counties in the San Francisco field division are now available, and field work at present is confined to investigations for special reports upon various economic minerals.

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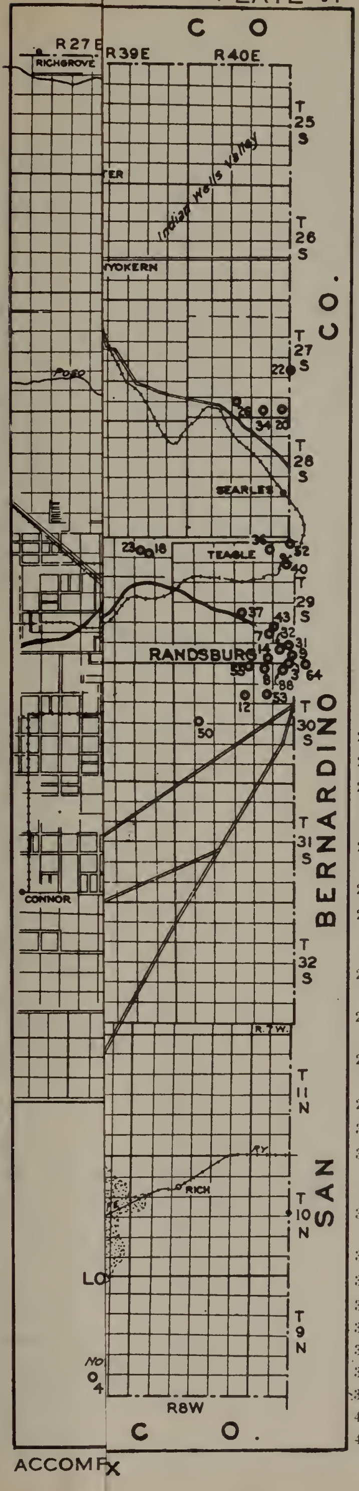
PLATE VI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KEY TO NUMBERS ON MAP

MINE

1. Amalie
2. Amy
3. Baltic
4. Barbarossa
5. Beauregard
6. Big Blue-Sumner
7. Big Butte
8. Big Gold
9. Big Dike
Black Hawk (64)
Bowman (65)
10. Bright Star
11. Blue Mountain
Bryan (66)
12. Buckboard
Bull Run (67)
13. Burning Moscow
Claraville Placers (68)
14. Consolidated
Dead River Placer (69)
Dearborn (70)
Double Standard (71)
Drunkards Dream (58)
15. Echo & Gray Eagle
Ederl Mine (60)
16. Elephant
Esperanza (72)
17. Exposed Treasure
18. Fine Gold (Placer)
19. Glen Olive
20. Gold Bug
21. Gold Hill
22. Gold Pass
Gold Peak (73)
Gold Standard (74)
23. Goler Canyon Placers
Granite King (75)
24. Gray Eagle
25. Gwynne
Hanover (76)
Helene-Galvin Placer (87)
26. Huntington
Iconoclast (77)
27. Joe Walker
Josephine (78)
28. Juan Dosie
Karma (79)
29. Kelso Creek Placers
30. Keyes
31. King Solomon
King Solomon
(Pleasant View) (59)
32. Little Butte
Little Joe (80)
33. Long Tom
34. Lost Keys
35. Mammoth
36. Minnehaha
37. Norden Placer
38. Old Cowboy
39. Ophir
40. Oro Fino Placer
41. Pennsylvania

MINE

42. Piute Cons.
Pine Tree (81)
43. Pinmore
44. Poso
45. Queen Esther
Rand (82)
46. Ricardo Placers
Riveredge Placer (86)
47. Ruby
48. Sailor Boy
49. San Antonio
50. Sidney (White)
St. Charles (83)
51. St. John
St. Lawrence Rand (88)
52. Summit Placers
Sunrise, Jenny Lind
& New World (61)
53. Sunshine
54. Tropico
Uncle Sam (62)
Voss Consolidated
Placer (84)
Warrington (63)
Whitmore (85)
55. Yellow Aster
56. Yellow Dog
57. Zenda
58. Drunkards Dream
59. King Solomon
(Pleasant View)
60. Ederl Mine
61. Sunrise, Jennie Lind
& New World
62. Uncle Sam
63. Warrington
64. Black Hawk
65. Bowman
66. Bryan
67. Bull Run
68. Claraville Placers
69. Dead River Placer
70. Dearborn
71. Double Standard
72. Esperanza
73. Gold Peak
74. Gold Standard
75. Granite King
76. Hanover
77. Iconoclast
78. Josephine
79. Karma
80. Little Joe
81. Pine Tree
82. Rand
83. St. Charles
84. Voss Consolidated
Placer
85. Whitmore
86. Riveredge Placer
87. Helene-Galvin Placer
88. St. Lawrence Rand

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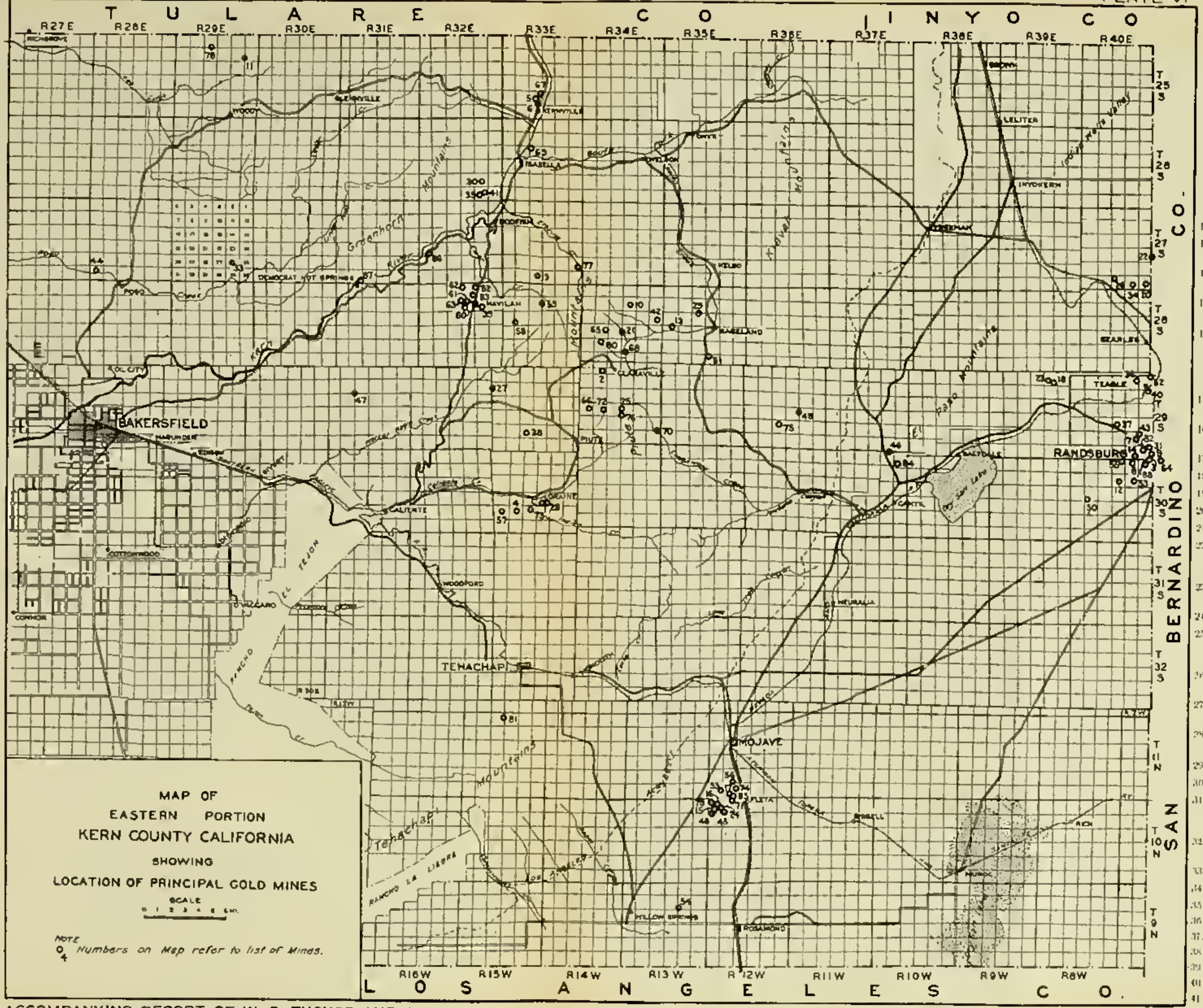
CALIFORNIA STATE DIVISION OF MINES
WALTER W BRADLEY, STATE MINERALOGIST

PLATE VI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KERNVILLE
ISABELLA
HAVILAH
GLENNVILLE
WOODY
CALIENTE
WOODFORD
KEENE
CAMBIA
JOHANNESBURG
INYOKERN
BROWN
LELITER
GARLOCK
CANTIL
SALTDALE
KELSO
WELDON
ONYX
BODFISH
CLARAVILLE
PIUTE
LORAINE
COTTONWOOD
OIL CITY
ROSAMOND
YELLOW SPRINGS
MURIC
FLETA
Greenhorn Mountains
Piute Mountains
Kiavah Mountains
El Paso Mountains
Tehachapi Mountains
Kern River
El Tejon
Rancho El Tejon
Rancho La Libre
Koehn Lake
Indian Wells Valley

MAP OF
EASTERN PORTION
KERN COUNTY CALIFORNIA
SHOWING
LOCATION OF PRINCIPAL GOLD MINES

SCALE
0 1 2 3 4 5 6 MI.

NOTE
○
4 Numbers on Map refer to list of Mines.

KEY TO NUMBERS ON MAP

MINE

1 Amalie
2 Amy
3 Baltic
4 Barbarossa
5 Beauregard
6 Big Blue-Sumner
7. Big Butte
8 Big Gold
9 Big Dike
Black Hawk (64)
Bowman (65)
10 Bright Star
11. Blue Mountain
Bryan (66)
12. Buckboard
Bull Run (67)
13 Burning Moscow
Claraville Placers (68)
14 Consolidated
Dead River Placer (69)
Dearborn (70)
Double Standard (71)
Drinkards Dream (58)
15 Echo & Gray Eagle
Edell Mine (60)
16. Elephant
Esperanza (72)
17 Exposed Treasure
18 Fine Gold (Placer)
19 Glen Olive
20 Gold Bug
21 Gold Hill
22 Gold Pass
Gold Peak (73)
Gold Standard (74)
23 Goler Canyon Placers
Granite King (75)
24 Gray Eagle
25 Gwynne
Hanover (76)
Helene-Galvin Placer (87)
26 Huntington
Iconoclast (77)
27. Joe Walker
Josephine (78)
28. Juan Dodie
Karma (79)
29 Kelso Creek Placers
30 Keyes
31 King Solomon
King Solomon
(Pleasant View) (59)
32 Little Butte
Little Joe (80)
33. Long Tom
34 Lost Keys
35 Mammoth
36 Minnehaha
37. Nonlen Placer
38 Old Cowboy
39 Ophir
40 Oro Fino Placer
41 Pennsylvania
42. Piute Cons.
Pine Tree (81)
43 Pinmore
44 Poso
45 Queen Esther
Rand (82)
46. Ricardo Placers
Riverside Placer (86)
47 Ruby
48 Sailor Boy
49. San Antonio
50 Sidney (White)
St. Charles (83)
51. St. John
St. Lawrence Rand (88)
52 Summit Placers
Sunrise, Jenny Lind
& New World (61)
53 Sunshine
54. Tropico
Uncle Sam (62)
Vose Consolidated
Placer (84)
Warrington (63)
Whitmore (85)
55 Yellow Aster
56 Yellow Dog
57. Zenda
58. Drinkards Dream
59 King Solomon
(Pleasant View)
60 Edell Mine
61. Sunrise, Jennie Lind
& New World
62 Uncle Sam
63 Warrington
64 Black Hawk
65. Bowman
66 Bryan
67. Bull Run
68. Claraville Placers
69 Dead River Placer
70. Dearborn
71. Double Standard
72 Esperanza
73 Gold Peak
74. Gold Standard
75 Granite King
76 Hanover
77. Iconoclast
78 Josephine
79 Karma
80 Little Joe
81. Pine Tree
82 Rand
83 St. Charles
84 Vose Consolidated
Placer
85 Whitmore
86. Riverside Placer
87. Helene-Galvin Placer
88 St. Lawrence Rand

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ACCOMPANYING REPORT OF W. B. TUCKER AND R. J. SAMPSON, JULY-OCTOBER, 1933, STATE MINERALOGIST'S REPORT XXIX

LOS ANGELES FIELD DIVISION

GOLD RESOURCES OF KERN COUNTY

By W. Burling Tucker, Mining Engineer, and R. J. Sampson, Mining Engineer

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  Streams ---------- 278
  Climatic Conditions ---------- 278
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  Mineral Resources ---------- 278
GOLD RESOURCES ---------- 278
  Discovery of Gold ---------- 278
  Production of Gold ---------- 280
  Gold Mining Districts ---------- 280
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INTRODUCTION

Kern County, because of its immensely productive oil fields, for many years was the leading mineral producing county of California. Kern County was surpassed in its mineral output by Los Angeles County, only, in 1924–1926, due to the increased production of petroleum from the latter county. The county was organized in April, 1866, and comprises 8003 square miles. It is the third largest county in the State, and is bounded on the north by Tulare, Kings and Inyo, on the south by Los Angeles and Ventura, on the east by San Bernardino, and on the west by San Luis Obispo. The development of the petroleum industry since 1900 has increased the mineral production to a great extent. Other outstanding development of minerals is the production of gold in the Randsburg district, and the discovery in the past ten years of new borax deposits near Kramer that has added materially to the mineral wealth of the county.

Topography.

The eastern and southern portions of the county contain the southern end of the Sierra Nevada Range, and this range merges with the Coast Range at Tehachapi. Its western boundary is along the summit of the Coast Range, and the southern end of the San Joaquin Valley makes up about one-third of the county's area. The southeastern slope of the Sierra and a large portion of the Mojave desert are included in the southeastern part. The county thus includes the slopes of two mountain ranges, a large and fertile valley plain, and an arid desert region. Along the northwestern border is the Diablo Range rising to a height of from 2000 to 3000 feet. From the junction of the Sierra Nevada and the Coast ranges, the San Emigdio Mountains project 20 miles northward into the valley.

TABLE OF GOLD QUARTZ MINES, PROSPECTS AND PLACER MINES, KERN COUNTY

Name of mine	Sec.	Twp.	Range	Owner's name, address	Elevation	Area, acres	Bibliography
Accident	32	11 N.	12 W.	C. C. Calkins, Mojave	2,700	40	R. XIV, p. 486.
Ajax	6	10 N.	12 W.	Karma Mining Co., E. L. Wegmann, Mojave	3,100	20	R. XIV, p. 499; XIX, p. 161; XXV, p. 37.
Alameda	36	29 S.	40 E.	Yellow Aster Mining Co., Randsburg	3,544	20	R. XIV, p. 514; Bull. 95, pp. 121-125; XXV, pp. 53-54.
Amalie	22	30 S.	33 E.	Mrs. J. J. Wellbaun, Caliente	3,000	420	R. XII, p. 141; XIII, p. 605; XIV, p. 486; XXV, p. 25.
American Golden Eagle	2, 10	28 S.	32 E.	Homer Bros., Havilah	4,500	100	R. XIV, p. 487; XXV, p. 25.
Amy (Gold State)	5, 22	29 S.	34 E.	Ed George, M. J. Errecart, Mojave	6,250	100	
Baltic	1	30 S.	40 E.	Albert Ancker, Transportation Bldg., Los Angeles	3,600	40	R. XIV, p. 487; XXV, p. 25: Bull. 95, p. 128.
Barbarossa	29	30 S.	33 E.	Mrs. J. J. Wellbaun, Caliente	3,600	140	R. XIV, p. 487: XXV, p. 25.
Barnett	16	30 N.	40 E.	Mrs. E. C. Randall, Bakersfield	3,700	20	
Beehive		28 N.	40 E.	Kern Rand Mines Co., Bakersfield	3,700	200	Bull. 95, p. 128: XXV. p. 27.
Bella Rufin	25	24 S.	33 E.	Herbert Gorman, Piute	6,000	20	R. XII, p. 142; XIV, p. 488; XXV, p. 27.
Beauregard	28	25 S.	33 E.	North Sumner Gold Mines, Kernville	2,800	6	R. XIV, pp. 487-488; XXV, p. 27.
Belmont	1	30 S.	40 E.	A. E. Graham, Whittier	3,500	28	
Big Blue-Sumner	28	25 S.	33 E.	Kern Development Co., R. Long, Kernville	2,800	95	R. VIII, p. 315; XIII, p. 191; XIV, p. 488; XXV, pp. 27-28; U. S. Comm. of Min. Statistics, Raymond, 1875.
Big Bonanza	16	29 N.	39 E.	J. E. McGinnis, Randsburg	3,400	20	
Big Butte	36	29 S.	40 E.	Butte Mining Co., 1231 Roosevelt Bldg., Los Angeles	3,550	20	Bull. 95, p. 132.
Big Gold	3, 4	30 S.	40 E.	Patrick Spelaine, Randsburg	3.500	74	Bull. 95, p. 130; XIX, p. 166; XXV, p. 28.
Big Dike	1, 2	30 S.	40 E.	Joe Shay & Ray Miller, Randsburg	3,600	100	
Billie Burke	35	29 S.	40 E.	Halsey Hawltome, Fillmore		20	
Black Hawk	7	30 S.	41 E.	Pittsburgh, Mt. Shasta M. & M. Co.; T. V. Scott, 516 Federal Bldg., Pittsburgh, Pa.	3,500	130	R. XIX, pp. 166-167; XIV, p. 489; XXV, p. 29; Bull. 95, pp. 130-131.
Black Mountain				Chas. Brewer, Los Angeles	3,300	160	R. XXV, p. 29.
Blue Gouge	28	25 S.	33 E.	Kern Dev. Co., R. S. Long, Kernville	3,600	350	R. XX, p. 40; XIV, p. 489; XXV, p. 30.
Bob Tail	6	10 N.	12 W.	Elephant Mining Co., Bert Fisher, Mojave	2,700	20	R XXV, pp. 32-33.
Bright Star	10	28 S.	34 E.	Mrs. Tracy, San Francisco	8,400	60	R. XII, p. 142; XIII, p. 187; XIV, p. 490; XXV, p. 30.
Bright Star	12	25 S.	29 E.	E. A. Paines, Bakersfield	2,500	40	R. XIV, p. 490.
Blue Mountain	11, 12, 14	25 S	29 E.	Blue Mountain Mining Co., Rodney McCormick, Bakersfield	3,600	40	R. XII, p. 296; XIII, p. 187; R. XIV, p. 492; XXV, p. 31.
Bowman	20	28 S.	34 E.	J. W. Walters & A. O. Griswald, Piute	7,100	60	R. XIV, p. 512.
Broken Axel	8	28 S.	40 E.	R. Salisbury, Lancaster	3,500	80	
Bryan	19	29 S.	34 E.	Donald G. Fugitt, El Segundo	5,500	100	
Buckboard	10	30 S.	40 E.	Albert Ancker, Transportation Bldg., Los Angeles	4,000	120	
Bull Run	28	25 S.	33 E.	Kern Development Co., R. S. Long, Kernville	2,980	5 65	R. XX. pp. 40-41; XIV, pp. 490-498; XXV, p. 30.
Bully Boy	2	30 S.	40 E.	United Mines, Inc., C. R. Hannaham, Randsburg	4,150	160	R. XIX, p. 171; XXV, pp. 30-31.
Burcham No. 1 & 2	34, 35	29 S.	40 E.	Yellow Aster Mining Co., Randsburg	3,400	40	R. XIII, p. 194; XIV, p. 514; XXV, pp. 53-54.
Burning Moscow	19	28 S.	35 E.	Piute Mining Co., W. J. Quackenbush, Bakersfield	5,400	240	
Butte Quartz		28 S.	40 E.	John Berg, Randsburg	3,500	20	Bull. 95.
Butte Wedge	35	29 S.	40 E.	Consolidated Mines, John Brock, 1402 S. Wilton. Los Angeles	3,550	120	R. XIV, p. 496; XXV, p. 31.

Caldwell	18	26 S.	33 E.	A. R. Kiester, Isabella	3,600	20	R. XIV, p. 490.
Castle Butte	24	29 S.	34 E.	J. N. Harvey, Bakersfield	6,000	120	
Chief	22	27 S.	29 E.	D. M. Dressel, Bakersfield	2,100	60	R. XIV, pp. 490-491.
Claraville Placers	27, 34	28 S.	34 E.	A. V. Fulton, Cantil	6,200	40	
Collar Button	10	28 S.	34 E.	W. B. Grant, Piute	8,100	14	R. XIV, p. 491.
Commonwealth	15	25 S.	33 E.	Kern Development Co., R. S. Long, Kernville	3,000	32	R. XIV, p. 491.
Consolidated Mines	35	29 S.	40 E.	Consolidated Mines Co., John Brock, 1402 S. Wilton Pl., Los Angeles	3,550	120	R. XIV, p. 491; XXV, p. 31; Bull. 95, pp. 132-133.
Content	28	25 S.	33 E.	Kern Development Co., R. S. Long, Kernville	3,000	20	R. XIV, p. 489; XXV, pp. 27-28.
David King	10	29 S.	34 E.	Jess Arants, Roscoe	6,500	40	
Dead River Placer	17	26 S.	33 E.	Charles Gibson, Isabella	2,500	40	R. XIV, p. 491.
Dead Tree	21, 22	29 S.	34 E.	J. C. & O. G. Geringer, Mojave	8,000	40	R. XIV, pp. 498-499; XXV, p. 36.
Deer Hunter	20	30 S.	34 E.	M. D. Elliott, Piute	4,100	60	R. XIV, p. 491.
Dearborn	36	29 S	34 E.	J. C. & O. G. Geringer, Mojave	5,400	80	
Double Standard	5	10 N.	12 W.	Mojave M. & M. Co., 261 I. W. Hellman Bldg., Los Angeles	2,700	40	R. XIX, p. 158; XIV, pp. 491-492; XXV, p. 31.
Dreadnot	11, 12, 14	25 S.	29 E.	Blue Mountain Mining Co., Bakersfield	2,500	170	R. XIV, p. 492; XII, p. 143; XXV, p 31.
Echo & Gray Eagle	6	10 N.	12 W.	A. Asher & Bert Fisher, Mojave	3,500	120	R. XIX, pp. 158-159; XXV, pp. 31-32.
Early Sunrise	26	26 S.	32 E.	W. A. Holesworth, Los Angeles	3,600	60	R. XIV, p. 492.
Eclipse	5, 34	25 S.	29 E.	D. Engle, Woody	2,000	20	R. XIV, p. 492.
Elephant	6	10 N.	12 W.	E. G. Staples, Mojave	3,000	100	R. XIV, p. 492; XIX, p. 159; XXV, pp. 32-33.
Ella	29	30 S.	33 E.	Rainey Bros., Lorraine	4 000	40	R. XIV, p. 493; XXV, p. 33.
Ellston	8	29 S.	31 E.	R. E. Ellston, Caliente	3,200	55	R XIV, p. 493; XXV, p. 33.
Esperanza & Joe Morena	(?) 20	29 S.	34 E.	Wm. Carpenter, Pomona; H. Wood, Mojave	4,500	200	R. XXV, p. 33.
Excelsior	6	10 N.	12 W.	Hunter Clark, Mojave	2,800	20	R. XIV, p. 493.
Exposed Treasure	32	11 N.	12 W.	Gordon Gray, San Diego	2,800	100	R. XIX, pp. 160-161; XIV, pp. 504-505; XXV, pp. 33-34.
Fair View	11	9 N.	13 W.	Burton Bros., Tropico	2,650	80	
Fair View	21	28 S.	32 E.		5,000	40	Register of Mines 1898-1906.
Fine Gold (Placer)		29 S.	39 E.	C. A. Irvine, W. A. Patterson, Lancaster	2,800	33	
Garnishee	35	26 S.	32 E.	Kern River Mining Co., 2240 San Fernando Rd., Los Angeles	3,200	40	R. XIV, p. 493.
G. B.	1	30 S.	41 E.	G. B. Mining Co.; Randsburg	3,600	22	R. XIV, pp. 493-494.
Gem	5	28 S.	31 E.	John Wilson Estate, San Francisco	2,600	160	R. XXV, p. 34.
Glen Olive	33	27 S.	33 E.	A. W. Stetson, San Francisco	7,500	120	R. XIV, p. 494; XXV, p. 34
Gladys	14	30 S.	40 E.	Herman A. Shultz, Bakersfield		120	
Glorietta	25	29 S.	40 E.	Calvert Wilson, Wilcox Bldg., Los Angeles		40	
Gold Bug	35	27 S.	40 E.	A. DeMayo, Searles	3,500	180	
Gold Crown	11, 12	30 S.	40 E.	Hiram E. Casey, 415 Spring Arcade Bldg., Los Angeles	4,000	46	R. XIV, p. 494.
Golden Group	34	30 S.	32 E.	New Ferris Mining Co., Caliente	2,000	100	R. XIV, p. 495; XXV, p. 35.
Gold Hill	21, 22	28 S.	34 E.	A. R. Greenslitt, R. E. Baughman, 1128 W. Seventh St., Los Angeles	7,400	140	
Gold Pass		27 S.	40 E.	F. Reynolds, Randsburg	3,300	100	
Goler Canyon (Placers)	1, 2, 11	29 S.	39 E.	Goler Canyon Mining Co., Inc., V. E. Britton & J. D. Murphy, 308 Spreckels Bldg., Los Angeles	2,500	1,500	
Gold Peak (Zada)	28	30 S.	33 E.	Gold Peak Min. Co., San Francisco; H. H. Blood, president	3,500	340	R. XIV, pp. 495-496; XXV, p. 35.
Gold Standard	32	11 N.	12 S.	C. C. Calkins, Mojave	3,000	40	R. XIX, p. 158; XIV, p. 491.
Good Hope	35	29 S.	40 E.	Cons. Mines Co., Randsburg: John Brock, sec., 1402 S. Wilton Pl., Los Angeles	3,550	156	R. XIV, p. 496· XXV, p. 31; Bull. 95.

TABLE OF GOLD QUARTZ MINES, PROSPECTS AND PLACER MINES, KERN COUNTY—Continued

Name of mine	Sec.	Twp.	Range	Owner's name, address	Elevation	Area, acres	Bibliography
Good Luck	16	27 S.	29 E.	A. P. Tucker, Tulare	1,750	40	R. XIV, p. 496; XXV, p. 35; XII, p. 191.
Gold King		28 S.	31 E.	Chas. Ball, Alhambra	2,400	180	R. XXV, p. 35.
Granite King	28	29 S.	36 E.	Chas. Burch, Mojave	4,500	80	
Gray Eagle	6	10 N.	12 W.	Bert Fisher, Mojave	3,500	60	R. XIV, p. 497; XIX, p. 158-159; XXV, pp. 31-32.
Grace	6	10 N.	12 W.	Percy Wegeman, Mojave	3,400	120	R. XIV, p. 497.
Great Unknown		31 S.	31 E.	Mrs. J. S. Bishop, Cantil	3,000	140	R. XXV, p. 36.
Grub Stake Placer		29 S.	38 E.	Chas. Keohn, Gypsite	3,500	40	R. XXV, pp. 36-37.
Gwynne	21, 22	29 S.	34 E.	Otto & Jack Geringer, Mojave	7,500	65	R. XII, p. 146; XIII, p. 192; XIV, p. 499; XXV, p. 36.
Hanover	21, 22	29 S.	34 E.	J. J. Wellbaun, Caliente	7,500	40	R. XIV, pp. 498-499; XXV, pp. 36-37.
Hawkeye	12	30 S.	40 E.	Eleanor Van Zant, c/o H. B. Quick, 32 Orange Ave., Pasadena	3,550	20	
Huntington		27 S.	40 E.	H. E. Willey, Inyokern	3,000	60	
Iconoclast	25	27 S.	33 E.	R. E. Porter, Isabella	8,000	60	R. XIII, p. 186; XIV, p. 497; XXV, p. 39
Illinois & Golden Bell	16	27 S.	33 E.	J. Peep, Bodfish	7,800	60	R. XIV, p. 497; XXV, p. 36.
Indian Queen	15	27 S.	29 E.	R. E. Dosworth, Tulare	1,600	40	R. XIV, p. 497; XXV, p. 36.
Indian Wells		27 S.	40 E.	Geo. E. Albertson, Inyokern	3,000	140	
Isabella	1	30 S.	40 E.	St. Lawrence Rand Min. Co., 417 Moore Bldg., Santa Ana	3,680	40	R. XXV, p. 59.
Jeff Davis	28	25 S.	33 E.	Lady Belle Min. Co., R. S. Long, Kernville	2,900	5	R. XIV, p. 498; XX, pp. 35-41; XXV, pp. 36-37.
Jennette	22	29 S.	34 E.	Otto & Jack Geringer, Mojave	8,000	40	R. XIV, p. 498; XXV, p. 37.
Jim Crow	35	29 S.	40 E.	E. B. Maginnis, Randsburg	3,800	20	
Joe Walker	7, 12	29 S.	33 E.	J. B. Haggin & Phoebe Hearst Estate, N. Y.	5,000	40	R. VIII, pp. 317-318.
Josephine	2, 3, 4, 5, 8	25 S.	29 E.	W. Adams, Corinth, Miss.	4,000	150	R. XII, p. 145; XIII, p. 191; XIV, p. 498; XXV, p. 37.
Juan Dosia	22	30 S.	33 E.	Martin J. Errecart, Piute	4,000	40	R. XII, p. 145; XIII p. 191.
Karma	6	10 N.	12 W.	E. L. Wegeman, Mojave	3,200	70	R. XIV, p. 499; XIX, p. 161; XXV, p. 37.
Kelso Creek Placers	16	28 S.	35 E.	Andrew Miller, Sageland	4,500	40	
Keyes	26	26 S.	32 E.	Kern River Min. Co., 2240 San Fernando Rd., Los Angeles	3,600	260	R. XII, p. 145; XIII, p. 191; XIV, p. 499; XXV, pp. 37-38; U. S. G. S. Min. Res. of U. S.
King Solomon	35	29 S.	40 E.	E. Shipsey, Los Angeles. Leased to Ilseng Co., Inc., Randsburg	3,900	100	R. XIV, p. 500; XXV, p. 38; Bull. 95, pp. 136-137.
King Solomon (Pleasant View)	9, 10	28 S.	33 E.	King Solomon Gold Min. Co., Los Angeles	6,500	100	R. XIV, p. 500.
Kramer Consolidated	21, 22	30 S.	33 E.	Allison Kramer, 1723 Pacific St., Bakersfield	6,000	50	
LaCross	2	30 S.	40 E.	H. Putman, Los Angeles	4,000	20	R. XIV, p. 500; XXV, p. 39.
Lady Belle	28	25 S.	33 E.	Lady Belle Min. Co., R. S. Long, Kernville	3,000	60	R. XIV, p. 501; XXV, pp. 42-43.
Laurel	26	27 S.	33 E.	John Hooper, Hobo Hot Springs	5,000	120	
Lehigh Valley		27 S.	40 E.	P. R. Light, C. F. Walker, Inyokern	3,500	40	
Lida	11	9 N.	13 S.	Tropico Mines Co.	2,800	180	R. XIV, p. 501; XXV, pp. 50-51.
Little Angel	2	28 S.	32 E.	S. C. Smith, Havilah	6,000	40	R. XIII, p. 192; XIV, p. 501; XXV, p. 39.
Little Bonanza	25	26 S.	32 E.	A. R. Lucey, Isabella	4,100	20	R. XII, p. 191; XIV, p. 501; XXV, p. 39.
Little Butte	35	29 S.	40 E.	Little Butte M. & M. Co., 612 Security Bldg., Los Angeles	3,000	60	R. XIV, p. 502; XXV, p. 39; Bull. 95.
Little Joe	29	28 S.	34 E.	Henry Redman, Piute	6,800	40	

Long Tom	21, 26, 27	27 S.	29 E.	Long Tom M. & M. Co.; Frank Hand, Fresno	1,600	130	R. XI, p. 238; XIV, p. 502; XXV, p. 39.
Lost Keys		27 S.	40 E.	D. J. O'Connor, M. L. Rubbert, Inyokern	3,500	200	
Mammoth	35	26 S.	32 E.	Mammoth Mt. Min. Co., J. H. Copein, Isabella	3,850	240	R. XIII, p. 193; XIV, p. 502; XXV, pp. 40-41.
Maltby (Placer)				J. Maltby, Woody. Leased to V. M. Osborn, Los Angeles		40	
McKidney	9	28 S.	32 E.	D. Fergusin, Havilah	4,300	60	R. XIII, p. 193; XIV, p. 503; XXV, p. 41.
Medie Lode	2	30 S.	40 E.	Arthur Asher, 601 Transportation Bldg., Los Angeles	3,500	20	
Minnehaha	2	29 S.	40 E.	Judge E. B. Maginnis, Randsburg	3,800	80	R. XIV, p. 503; XXV, pp. 41-42; Bull. 95, pp. 137-138.
Mojave Bonanza	6	10 N.	12 W.	Alice A. Cullen, S. California Music Bldg., Los Angeles	3,000	20	
Nellie Dent	28	25 S.	33 E.	Kern Development Co., R. S. Long, Kernville	2,600	54	R. XIV, p. 505; XXV, p. 42; XX, p. 41.
Nemitz	21, 24	30 S.	33 E.	Nellie W. Nemitz, Caliente	2,300	498	
New Mex		29 S.	38 E.	Mrs. J. S. Bishop, Cantil	2,400	60	R. XXV, p. 42.
North Sumner	28	25 S.	33 E.	North Sumner Gold Mines, Inc., R. S. Long, Kernville	2,860	115	R. XIV, pp. 487-488; XX, pp. 36-40; XXV, pp. 42-43.
Nymph & Last Chance		9 N.	13 W.	W. H. Hoeger, 4639 Prospect Ave., Los Angeles		40	
Norden Placer	22	29 S.	40 E.	Yellow Channel Min. Co.; Gordon Cole, 616 N. Manhattan Pl., Los Angeles	2,500	120	R. XXV, p. 43; Bull. 95, pp. 145-147.
Old Baldy	1	30 S.	40 E.	Marie E. Edmunds, 864 S. Vermont Ave., Los Angeles		60	
Old Cowboy	28	30 S.	33 E.	A. E. Bryson, Los Angeles	2,800	80	R. XIV, p. 505; XXV, p. 43.
Operator (Phoenix)	35	29 S.	40 E.	Operator Cons. Min. Co., 1304 Russ Bldg., San Francisco	3,550	140	R. XIV, p. 507; XXV, pp. 43-44; Bull. 95, p. 140.
Ophir	11	28 S.	32 E.	J. E. Waters, Havilah	4,200	40	R. XIII, p. 194; XIV, p. 506; XXV, p. 44.
Oro Fino Placer	1, 12	29 S.	40 E.	D. A. Woodruff, 323 S. Hancock St., Los Angeles	3,300	190	R. XXV, pp. 48-49; Bull. 95, p. 147.
Orphan Girl	12	29 S.	40 E.	O. A. Phillips, D. S. Spearman, Randsburg	3,800	20	R. XXV, p. 44.
Osses		29 S.	36 E.	Domingo Bordo, Bakersfield		20	
Pearl Wedge	11	29 S.	40 E.	Mrs. Grace Jewitt, Los Angeles	3,800	20	R. XXV, p. 44.
Pennsylvania	35	26 S.	32 E.	W. B. Walker, Keyesville. Leased to C. B. Ganthier, Los Angeles	3,350		R. XXV, p. 45.
Phoenix	35	29 S.	40 E.	Operator Cons. Min. Co., 1304 Russ Bldg., San Francisco	3,550	140	R. XXV, pp. 43-44.
Pine Tree	3, 4	11 N.	15 W.	George Gordon, Tehachapi	5,000		R. XIII, p. 194; XIV, p. 506; XXV, p. 45.
Piute Cons.	13	28 S.	34 E.	Piute Cons. Mining Co.	7,500	100	R. XIV, pp. 506-507; XXV, p. 45.
Piute	10, 11, 14, 15	9 N.	13 W.	Tropico M. & M. Co., Rosamond	4,000	220	R. XIV, p. 512; XXV, pp. 50-51.
Pinmore	26	29 S.	40 E.	Croesus Mining Co., Randsburg	3,500	40	R. XIV, p. 507.
Poso	30, 31	27 S.	28 E.	Poso M. & M. Co.; E. W. McCutchin, Bakersfield		260	R. XXV, p. 45.
Polar Bear	29	27 S.	33 E.	G. F. Haskins, Isabella	3,200	80	R. XIV, p. 507.
President	4	27 S.	32 E.	U. T. Smith, Isabella	3,200	20	R. XIV, p. 507.
Pyramid (Tip Top)		29 S.	40 E.	P. J. Osdick, Randsburg	4,000	40	R. XIV, p. 508.
Queen Esther	6	10 N.	12 W.	Harvey Mudd, 1206 Pacific Mutual Bldg., Los Angeles	3,200	20	R. XIV, p. 508; XIX, p. 162; XXV, p. 46.
Rand	3	28 S.	32 E.	G. E. Bennett, Caliente	4,500	20	R. XIV, p. 508.
Rand Placers	6, 9	29 S.	39 E.	Yellow Aster M. & M. Co., Randsburg	3,550	80	
Red Hill	21	25 S.	33 E.	North Sumner Gold Mines, Inc.; R. S. Long, Kernville	3,500	24	R. XIV, p. 509; XXV, p. 46.
Red Hill Group	16, 21	25 S.	33 E.	Orejana Min. Co.; C. S. Long, Hayward	3,600	220	R. XIV, p. 509.
Reform	6, 9	28 S.	33 E.	Nora S. Coulston, Box 66, Pasadena	3,800	40	

TABLE OF GOLD QUARTZ MINES, PROSPECTS AND PLACER MINES, KERN COUNTY—Continued

Name of mine	Sec.	Twp.	Range	Owner's name, address	Elevation	Area, acres	Bibliography
Ricardo Placers	2, 35	29 &	37 E.	Rudolph Hagen, Ricardo	2,300	3,000	
		30 S.	33 E.	Earnest Griffith, Bakersfield	3,000	160	R. XII, pp. 456-458; XIII, p. 195; XXV, p. 46.
Riches & Wealth Placers	19	26 S.	32 E.	George King, Isabella	6,000	20	R. XXV, pp. 46-47.
Rose	31	26 S.	31 E.	Geo. Thatcher, Bakersfield. Leased to Ruby			R. XIV, p. 509.
Ruby	9, 16, 17	29 S.		Min. Co.; Thos. W. McManus, pres., 213			
				Haberfeldt Bldg., Bakersfield	3,600	2,080	
			40 E.	Judge E. B. Maginnis, T. T. O'Leary, Randsburg	4,000	40	
Rustler & San Diego	2	29 S.	12 W.	C. C. Moore, Mojave	2,500	69	R. XIV, p. 509; XXV, p. 47.
Sailor Boy (Ben Hur)	6, 10	10 N.	36 E.	J. Martino, Bakersfield; Mrs. Lee, San Fer-			R. XIV, p. 510; XXV, p. 47.
San Antonio	22, 23	29 S.		nando. Under lease to San Antonio Min. Co.;			
				Geo. Callaher, pres., Bakersfield	4,150	280	
			40 E.	Santa Ana Gold Mines Co.; F. Layton, pres.,			R. XXV, p. 47.
Santa Ana (Napoleon)	11	30 S		Los Angeles	4,000	--------	
			40 E.	A. C. White, Randsburg	4,300	260	R. XIV, p. 509; Bull. 95.
Sidney (White)	----------	30 S.	32 E.	A. Neelson, Havilah	4,200	240	R. XIV, p. 510; XXV, p. 51.
Southern Cross	3, 10	28 S.	40 E.	S. Montgomery, Randsburg	3,800	75	R. XIV, p. 510; XXV, p. 47.
Stanford	12	30 S.	40 E.	Ray Young, Mojave; Ross Hand, Burbank	3,500	80	R. XIV, p. 510; XXV, p. 47.
Stellar	----------	27 S.	32 E.	Kate Reese Estate; Mrs. Gus Miller, Havilah	6,000	80	
St. Charles	3, 10	28 S.	35 E.	J. H. Copelin & Andrew Miller, Isabella	4,900	140	
St. John	33, 34	28 S.	40 E.	St. Lawrence Rand Min. Co., Santa Ana	3,680	40	R. XXV, pp. 47-48.
St. Lawrence Rand	1	30 S.	40 E.				R. XIX, p. 170; XXV, p. 59; Bull. 95, p. 143.
Summit Gold Placers	1, 6, 12	29 S.	41 E.	A. L. Cram, Searles	3,300	1,640	
			33 E.	Kern Development Co.; R. S. Long, Kernville	3,000	18	R. XXV, pp. 48-49.
Sumner & North Extension	28	25 S.	32 E.	C. E. Pierrel, Bodfish	3,800	40	R. VIII, p. 315; XIV, p. 511; XX, pp. 35-40; XXV, p. 49.
Sunset	10	27 S.	40 E.	T. W. Atkinson Estate, 301 Holly Ave., Compton	4,000	40	R. XIV, p. 511.
Sunshine	11	30 S.	34 E.	A. O. Griswald, Piute	7,000	60	R. XIV, p. 512; XXV, p. 49; Bull. 95, p. 144.
Surprise	29	28 S.	40 E.	B. M. Atkinson, Box 21, Compton	--------	40	
Topsy	36	29 S.	34 E.	A. O. Griswald, Piute	7,400	60	
Trestle (Bowman)	18	29 S.	13 W.	Tropico M. & M. Co.; Clifford Burton, Rosa-			R. XIV, p. 512.
Tropico	10, 11, 14, 15	9 N.		mond	2,800	220	
			33 E.	North Sumner Gold Mines, Inc.; R. S. Long,			R. XIV, p. 512; XXV, pp. 50-51.
Urbana & Frank	28	25 S.		Kernville	3,000	24	
			37 E.				R. XIV, pp. 512-513; XX, p. 39; XXV, p. 51.
Voss Cons. Placer	1	30 S.	38 E.	J. D. Voss, Garlock	3,000	140	
	6	30 S.	34 E.	Edward Doble, Piute	8,000	60	R. XXV, p. 51.
Wall Street (Summit)	11	28 S.	12 W.	Standard Gold Mining Co., Mojave	3,500	20	
Wedge	32	11 N.	40 E.	A. C. White, Randsburg	4,300	260	
White (Sidney)	16, 17	30 S.	40 E.	Frank Wycoff, Randsburg	3,500	20	R. XIV, p. 510; XXV, p. 51.
Whipperwill	35	29 S.	40 E.	White Horse Rand Min. Co., 2020 2d St.,			
White Horse	1	30 S.		Selma	3,550	60	
			32 E.	E. A. Braden, Bodfish	4,300	20	R. XIX, p. 171; XXV, p. 60; Bull. 95, p. 144.
White Star	11	27 S.	40 E.	P. Erdman, Inyokern	3,500	40	R. XIV, p. 513; XXV, p. 51.
White Star	----------	27 S.					

Whitmore	32	11 N.	12 W.	W. K. Whitmore, J. E. Whitmore, Mojave	2,700	200	R. XIX, pp. 152-153; XXV, p. 52.
Yellow Aster	2, 3, 34, 35	29 & 30 S.	40 E.	Yellow Aster M. & M. Co.; Albert Anker, pres., 602 Transportation Bldg., Los Angeles	4,000	796	R. XIII, p. 194; XIV, p. 514; XXV, pp. 53-54; Bull. 95, pp. 121-125.
Yellow Dog	29, 32	11 N.	12 W.	Yellow Dog Min. Co., P. O. Paulson; 715 Hibernian Bldg., Los Angeles	2,800	160	R. XIX, pp. 163-164; XXV, p. 55.
Yellow Dog Extension	33	11 N.	12 W.	Yellow Dog Extension Min. Co., Los Angeles	2,800	100	R. XIX, p. 164; XXV, pp. 55-56.
Zenda	30	30 S.	33 E.	Zenda Mining Co., 120 Broadway, N. Y.	3,500	900	R. XIV, p. 515; XX, pp. 41-42; XXV, p. 65.

Streams.

Kern River and Poso Creek are the principal streams of the county. Kern River rises among the highest peaks of the Sierra Nevada in the northeastern part of Tulare County, having two large forks flowing southwesterly 125 miles. This river is one of the important streams of the State for the generating of hydroelectric power. It enters the San Joaquin Valley near Bakersfield, then flowing westwardly, divides into many channels. This river supplies most of the water for irrigation purposes for the fertile lands of the valley.

Poso Creek has its source in many branches high up in the Greenhorn Mountains, and flows southerly some 25 miles, then westerly and southwesterly until it sinks in the valley, after a winding course of 75 miles.

Climatic Conditions.

Mining operations can be pursued throughout the entire year, as the snowfall, even in the mountain regions, is not heavy enough to interfere with the work. In the valley the rainfall amounts to about eight inches per year. The temperature in July and August may reach 110° F.

Transportation.

Two great transcontinental railroads, the Southern Pacific, and the Santa Fe, pass through the center of the county. From Mojave the Southern Pacific operates a branch line to Owens Valley connecting with the Nevada and California Railroad at Owenyo, Inyo county. The main State highway, known as the Valley Route from Los Angeles to San Francisco, passes through the county.

The productive oil fields and mining districts are connected with the main highway system by good roads, the principal ones being paved.

Mineral Resources.

Kern County, because of its immensely productive oil fields, for many years stood preeminent among all the counties of California in the value of mineral output, the exact figures for 1932 being $28,069,925. During 1932 sixteen different mineral substances were produced. Among the mineral resources developed and undeveloped are antimony, asphalt, borax, brick, clay, cement, copper, feldspar, fullers earth, gems, gold, gypsum, iron, lead, limestone, magnesite, marble, mineral paint, natural gas, petroleum, potash, pumice, salt, silica, silver, soapstone, soda, sulphur and tungsten.

GOLD RESOURCES

Discovery of Gold.

The first discovery of gold in Kern County was made by a member of General Frémont's party in 1851, at Greenhorn Gulch, near Kern River. In 1852 the Keyes and Mammoth mines were located in the Keyesville district, both of which were steady producers for over sixty years. In 1861 the mines of the Cove district were discovered, the largest producer being the Big Blue and Sumner group of mines. The mines of the Cove district have a production record of $5,000,000 to $8,000,000.

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KERN COUNTY—MINERAL PRODUCTION 1880-1932

Year	Asphaltum		Brick		Copper		Fuller's earth		Gold, value	Lime		Limestone		Silver, value	Natural gas		Petroleum		Miscellaneous and unapportioned		
	Tons	Value	M	Value	Pounds	Value	Tons	Value		Barrels	Value	Tons	Value		M cu. ft.	Value	Barrels	Value	Amount	Value	Substance
1880									$94,214					$390							
1881									100,000					14,000							
1882									260,000					20,000							
1883									160,000					5,000							
1884									100,000					5,000							
1885									72,003												
1886									94,040					1,721							
1887									72,358					150							
1888									60,000					2,500							
1889									242,676					7,517							
1890									117,341					586							
1891									107,735					61							
1892									107,738					73							
1893									83,665					1,754							
1894	6,000	$138,000							310,707	33,000	$26,500			39,700			14,215	$69,334	92 tons	$3,720	Antimony.
1895	1,400	28,000							231,433	25,400	24,660		$10,000	46,064			116	116	33 tons	1,485	Antimony.
1896	2,484	44,680							590,607	37,100	32,329	5,000	5,000	34,650			235	235	15 tons	2,250	Antimony.
1897	4,650	56,350	1,100	$6,600					754,313	53,400	70,370			10,471					25 tons	3,500	Antimony.
1898	1,850	50,000	2,000	14,000					1,017,930	42,000	20,900			6,543			10,000	10,000	220 tons 40 tons 27 tons	1,100 1,200 3,382	Coal. Antimony Borax.
1899	2,537	57,670	1,600	41,400			620	$12,400	863,414	64,700	57,600			6,810			15,000	13,500			
1900	701	14,020	2,525	17,300	4,000	$750	500	3,750	805,232	57,721	51,700			147,736			919,276	827,348		859,927	Unapportioned, 1900-1909.
1901	3,112	43,126	4,600	23,400	429,248	67,606	1,000	19,500	1,007,050	62,000	82,700			40,497			3,902,125	1,131,616	1,600 lbs. 50 tons	64 8,350	Lead. Antimony.
1902	10,150	101,500	3,500	24,500	235,840	27,122	987	19,246	1,165,952	99,300	80,856			99,135			9,777,948	1,955,585	1,000 tons	8,000	Gypsum.
1903	8,006	100,767	9,000	30,000	4,300	559	250	4,750	1,022,353	101,661	76,246			114,014			18,001,148	3,600,230	28 tons 1,000 tons	83 8,000	Bituminous rock. Gypsum.
1904	12,451	124,110	700	4,900			500	9,500	1,426,523	178,038	172,000			151,189			19,608,045	3,131,409			
1905	10,586	105,860	750	6,000					1,160,971	279,050	255,500		44,000	134,944			17,069,715	3,174,966	53 tons 1,350 tons 52 tons	54 11,000 18,800	Clay. Gypsum. Tungsten.
1906	23,136	231,360	4,275	34,200					806,117	295,613	267,096			129,503			13,626,000	3,765,200	215 tons	752 183,600	Clay. Tungsten.
1907	20,443	260,158	2,168	18,428					878,798	175,000	169,822			60,033			15,701,308	4,673,867	1,000 tons	5,500	Gypsum.
1908	50,000	475,000	2,050	19,552					827,087	116,717	87,788			96,550			18,777,571	9,388,935	500 tons	2,000	Gypsum.
1909	54,599	655,391	3,365	29,634			359	5,395	654,799	115,709	88,869			101,633	38,000	$2,714	24,649,758	12,565,246	1,700 tons 4,781 lbs.	500 8,300 174	Gems. Gypsum. Lead.
1910	76,605	811,846	5,332	63,711					619,974	99,157	80,198		4,331	35,041	975,724	47,364	40,641,159	17,925,212	1,675 tons 160,000 tons 242 tons	8,305 112,000 121	Gypsum. Rubble. Clay.
1911			5,603	41,126	29,441	3,680			557,471	96,500	82,025	600	400	5,833	1,654,380	165,438	40,562,825	20,207,906	230,950 tons 853 tons 2,417 lbs.	107,880 4,245 109	Crushed rock. Gypsum. Lead.
1912			1,590	23,120					830,421	162,831	124,894			11,480	4,400,000	325,454	51,448,067	21,762,532	8,479 tons 19,664 lbs.	18,188 885	Gypsum. Lead.
1913			1,625	22,000	3,498	542			649,712	135,000	91,200			11,851	7,111,237	568,899	58,609,412	27,038,474	208 tons 16,000 tons 1,370 lbs.	104 22,750 61 600	Clay. Gypsum. Lead. Other minerals.
1914			3,834	29,214	7,394	983			594,337	81,100	65,100			8,002	6,508,868	390,532	65,332,633	20,721,046	346 tons 82 tons 379 lbs. 20,000 tons	172 320 15 50,000 180,575	Clay. Gypsum. Lead. Salt. Other minerals.
1915					1,047	183			983,319	55,176	39,523	1,425	1,710	13,316	12,163,461	737,638	54,810,169	23,184,913	267 tons 84,371 lbs.	11,301 3,965 59,319 299,997	Antimony ore. Lead. Miscellaneous stone. Cement, pottery clay, fuller's earth, gypsum, magnesite, salt, tungsten.
1916			3,177	23,821	21,754	6,089	(1)		717,042	(1)				6,745	10,679,658	1,379,033	54,120,500	34,691,240	145 tons 21,274 lbs. 4,100 tons 193 tons	5,650 1,675 30,047 23,700 63,723 482,387 363,516	Antimony ore. Lead. Lime and limestone. Silica. Miscellaneous stone. Tungsten concentrates. Cement, clay, feldspar, fuller's earth, magnesite, quicksilver, salt.
1917			and tile	22,785	251,225	68,584			537,852	(1)		(1)		7,813	25,819,376	1,445,850	53,055,026	17,357,104	113 tons 9,084 lbs. 300 flasks 49 tons	16,041 833 27,250 31,787 58,148 139,345	Antimony ore. Lead. Quicksilver. Miscellaneous stone. Tungsten concentrates. Clay, feldspar, lime, limestone, magnesite, salt.
1918			1,678	16,380	95,550	23,608			246,127	23,015	23,615	(1)		7,817	23,545,128	1,507,912	19,049,917	61,410,496		311 174,419	Miscellaneous stone. Lead, limestone, magnesite, manganese, quicksilver, salt, tungsten.
1919			1,709	175,112			(1)		150,559	86,952	112,724	(1)		8,402	25,363,7[illegible]	1,618,910	47,731,035	64,440,942	17,000 tons	51,000 28,130 9,345	Salt. Miscellaneous stone. Fuller's earth, limestone, quicksilver.
1920			3,850	56,550	206	38			61,187	76,395	108,733			8,385	34,912,665	1,810,147	50,664,438	86,831,901	22,000 tons 3,060 tons	87,000 20,100 31,180 108,270	Salt. Silica. Miscellaneous stone. Cement, gems, lead, quicksilver.
1921			5,840	85,820					84,098	72,629	141,491			1,697	10,136,930	1,926,707	57,134,915	97,639,407	18,500 tons	93,500 38,208 829,115	Salt. Miscellaneous stone. Cement, gypsum, limestone, silica.
1922			5,052	60,652					124,337					6,534	47,644,631	2,282,100	53,512,157	64,803,222	18,000 tons	66,000 35,583 1,166,582	Salt. Miscellaneous stone. Cement, copper, lime, silica, lead.
1923			5,271	68,375					107,051	17,985	214,163	(1)		33,161	42,421,692	2,051,656	45,952,704	37,629,300	15,921 tons	97,336 9,225 1,602,138	Salt. Miscellaneous stone. Cement, clay (pottery), gypsum, limestone, pumice, sulphur.
1924			(1)	23,058					154,132	9,130	96,860			35,902	47,851,308	2,622,651	61,175,405	69,572,034	10,500 tons	41,115 23,058 5,241 1,719,635	Salt Brick and clay (pottery). Miscellaneous stone. Arsenic, cement, copper, lead, pumice, sulphur.
1925			(1)						135,545					7,455	45,049,845	2,290,605	58,852,742	84,255,194	6,890 tons	28,858 3,000 2,659,166	Salt Miscellaneous stone. Antimony, borates, cement, brick, clay (pottery).
1926			4,591	55,140					135,508	(1)				4,667	14,182,140	2,158,807	51,549,648	78,957,897	11,279 tons	41,116 28,000 2,144,889	Salt Miscellaneous stone. Cement, feldspar, fuller's earth, gypsum, lime, pumice, silica.
1927			4,835	50,438					171,100	(1)				8,932	39,401,478	2,057,607	51,570,412	58,738,099	14,990 tons	69,839 79,510 3,553,161	Salt Miscellaneous stone. Borates, cement, clay (oil well mud), copper, feldspar, gypsum, lime, onyx, pumice.
1928			2,126	30,791			(1)		186,453	(1)				5,245	35,107,062	1,916,707	11,090,138	36,503,054		74,643 1,043,778	Miscellaneous stone. Antimony, borates, cement, clay (pottery), feldspar, fuller's earth, gypsum, lime, pumice, salt.
1929			3,503	44,681			(1)		148,421					2,312	34,409,095	1,801,950	43,577,420	32,299,554	58,551 tons	85,845 361,596 4,011,550	Clay (pottery). Miscellaneous stone. Borates, cement, fuller's earth, volcanic ash, quicksilver, salt, tungsten.
1930			(1)		(1)		(1)		165,435					1,757	27,609,423	1,290,020	44,170,810	37,015,139	111,301 tons 371,123 tons	2,335,190 117,834 450,351 1,012,181	Borax. Clay. Miscellaneous stone. Brick, cement, copper, feldspar, fuller's earth, gems (rose quartz), gypsum, lead, quicksilver, salt, volcanic ash.
1931			(1)		207	19			202,108					2,534	26,077,942	1,444,732	35,794,138	22,765,072	27,499 tons 6,307 lbs.	46,668 233 105,958 4,212,034	Clay (pottery and oil well drilling). Lead Miscellaneous stone. Bentonite, borates, brick, cement, feldspar, gypsum, mineral water, volcanic ash, quicksilver, salt.
1932			(1)		(1)		(4)		206,250	(1)		(1)		3,957	26,234,262	1,201,293	35,552,561	23,393,685	14,770 tons	22,871 49,077 3,102,892	Clay (pottery and oil well drilling). Miscellaneous stone. Bentonite, borates, brick, cement, copper, lead, volcanic ash, salt.
Total	250,610	$3,327,555	110,555	$1,015,933	1,086,740	$169,763	4,216	$74,531	$23,165,044	2,053,042	$2,758,912	7,025	$65,441	$1,545,842	617,127,116	$33,005,202	4,390,532,177	$1,120,012,430		$38,778,213	

[1] See under 'Unapportioned.'

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The Joe Walker mine, which is situated in Walkers basin, was discovered in 1865 and operated continuously until 1875. There was a twenty-stamp mill on the property and the production record was $600,000.

St. John mine was discovered in 1860 and operated by Senator Jones and Senator Stewart, of Nevada, until 1875. There were two mills on the property, with production record of $700,000.

The discovery of placer gold at Goler in 1893 led to the development of quartz mines in this section. The Yellow Aster mine, the largest gold producer in southern California, was discovered by John Singleton and William Burcham in 1895 and has been worked continuously to date. The development of the Yellow Aster mine led to the discovery of other productive mines and caused the Rand district to be the largest producing district in the county. The total gold production from this district is estimated from $15,000,000 to $20,000,000.

In 1894 gold was discovered in the Mojave mining district which lead to the development of the following productive mines: Queen Esther, Exposed Treasure, Karma, Elephant, Echo and Gray Eagle. There was a revival of interest in this district in 1922 due to the discovery of high-grade gold ore in a small butte north of the Exposed Treasure mine.

In June, 1922, the Yellow Dog Mining Company was organized for the development of the property. In 1931 there was increased activity in the Mojave district, due to the operations of leasers on the different mines in the district, there being fifty to seventy leasers operating on the Exposed Treasure, Elephant, Echo, Gray Eagle and Yellow Dog mines.

The ore extracted from these properties was hauled 17 miles to the Tropico mines where it was milled by Burton Brothers' custom mill. In 1931 the production of leasers ore from the Mojave district amounted to 1358 tons of ore from which was recovered $28,270, with an average value of $20.81 per ton. In 1932, 3381 tons of ore were produced by leasers from which was recovered $70,000, with an average value of $20.70 per ton.

For many years leasing has been the practice in the gold mines of the Randsburg district. In the Yellow Aster mine, since 1921 (through 1932) there has been produced by individual leasers $815,000 from ores which averaged $20.27 per ton. This ore was milled in the company's plant on the property and is in addition to the production from ores mined by the company.

Considerable activity in a small way has recently been shown in the old Rademacher district, some twelve miles north of Randsburg. Here twelve properties are being developed with crews varying from two to six men. Two engine-driven arrastres and one small mill are under construction in this area. Water is available in the valley about four miles distant from the most remote of these prospects.

Work on the placers of Goler Gulch and vicinity has been actively carried on for the past two years. In the Goler and Summit Diggings area about one hundred men have been engaged in taking gold from the benches on the sides of the gulches as well as from shafts sunk to bedrock in the bottom of the canyon.

Production of Gold.

The production of gold in Kern County in 1932 amounted to $296,250 as compared with $202,108 in 1931. The production for 1933 will, no doubt, show considerable increase over that of 1932.

A table showing the reported production of some of the more important mines of the county is printed below. While these figures are not compiled from any official records, it is believed that they are substantially correct.

Table of reported production of some of the mines of Kern County:

Amalie District		
Amalie mine		$600,000
Cove District		
Big Blue and Sumner mines		2,000,000
Beauregard		600,000
Jeff Davis		500,000
Lady Belle		500,000
Green Mountain District		
Bright Star mine		600,000
Keyes District		
Keyes mine		300,000
Mammoth mine		500,000
Mojave District		
Exposed Treasure mine		2,000,000
Karma mine		300,000
Queen Esther mine	about	500,000
Gray Eagle and Echo mines	about	200,000
Pioneer District		
Glen Olive mine		500,000
Rand District		
King Solomon mine		500,000
Operator Divide (Phoenix) mine		600,000
Little Butte mine		150,000
Sunshine mine		1,000,000
Sidney mine		200,000
Yellow Aster mine		12,000,000
Other Districts		
Joe Walker mine		600,000
Saint John mine		700,000
Pine Tree mine		250,000
Tropico mines	about	500,000

A brief description of some of the various mining districts is followed by a more detailed account of the individual mines arranged alphabetically and without regard to the districts in which they occur.

Gold Mining Districts.

Amalie, also known as the Agua Caliente district, includes the territory between the southerly summits of the Piute Mountains and Caliente Creek. It is largely contained in T. 30 S., R. 33 and 34 E. Elevations range from 2500 feet on Caliente Creek to 7000 feet on the adjacent summits.

The rocks of the district are granitic within which are found narrow belts of slate and schist. The principal veins of this area occur in quartz-porphyry.

It is easily accessible over a good road from the town of Caliente, a station on the Southern Pacific Railroad.

Clear Creek district is about twenty-five miles north of Caliente. It is in T. 28 S., R. 32 E., M. D. M. Altitudes range from 3000 to 5500 feet.

The formation is granite or granodiorite traversed by numerous diorite dikes and containing some narrow belts of schist.

Havilah, a small settlement on Clear Creek, is the post office.

Cove, one of the most important districts in the county, is situated in T. 25 S., R. 33 E., M. D. M. It is on Kern River, some 45 miles northeast of Bakersfield and is accessible from that point over a paved highway. The town of Kernville lies within the boundaries of this district. Elevations range from 2600 to 5000 feet.

The rocks of the district are granite and schist, the former predominating. Nine principal lodes show bold outcrops for a considerable distance in this area. Of these the most important is the Sumner. This lode, which is on the granite-schist contact, contains three wide veins from which there has been produced approximately $2,000,000. The Nellie Dent and Commonwealth are also wide lodes which carry low-grade gold values.

Ideal climatic conditions, an abundance of water and topography favorable to cheap development and low mining costs, make this one of the most attractive mining districts of the county.

Goler Canyon Placer district is on the southeast slope of El Paso Mountains, 7 to 10 miles west of Randsburg. It extends from Last Chance Canyon on the southwest to Summit Diggings on the northeast, a distance of about 12 miles.

It is not known that placer deposits occur in this entire area but gold has been recovered in Last Chance Canyon, Benson Gulch, Goler Canyon and Summit Diggings. Considerable work, in a small way, has been done here in the past two years. The only water obtainable in the district is from wells in Goler Canyon or from shafts sunk to bedrock in the bottom of the canyon. On this account most of the gold has been recovered by dry washers.

The deposits are presumed to be the delta gravels of short streams which flowed into an ancient sea and are therefore distributed at intervals along this old shore line.

According to Haley[1] this shore line is traceable from the Owens River basin, through Goler, Summit Diggings and Copper Canyon to Coolgardie but is lost as the formations dip under the recent wash near Barstow.

The auriferous gravels are found in benches from 30 ft. to 80 ft. above the bed of the present canyons and there is a reconcentration of values on bedrock in the bottoms of these gulches.

Greenhorn Mountain district, some 48 miles by road north of Caliente, is in T. 26 and 27 S., R. 31 and 32 E., M. D. M. This area

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[1] Haley, Chas. S., Gold placers of California; Cal. State Min. Bureau Bull. 92, 156, 1923.

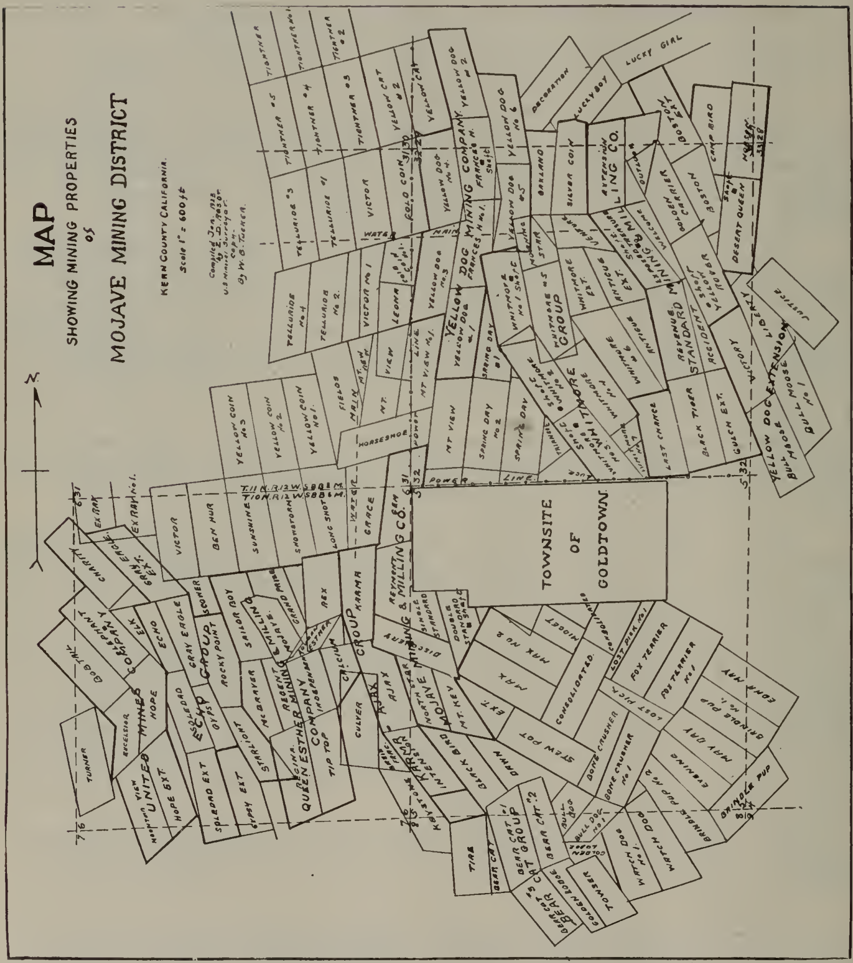
MAP
SHOWING MINING PROPERTIES
of
MOJAVE MINING DISTRICT
KERN COUNTY CALIFORNIA.
Scale 1" = 600 ft
N.
TOWNSITE OF GOLDTOWN
YELLOW DOG MINING COMPANY
WHITMORE GROUP
STANDARD MINING CO.
QUEEN ESTHER MINING COMPANY
ECHO GROUP
UNITED MINES COMPANY
MOJAVE MINING & MILLING CO.
KRAMA GROUP
CAT GROUP
YELLOW DOG EXTENSION
POWER LINE
T.11 N. R.12 W. S.B.B.& M.
T.10 N. R.12 W. S.B.B.& M.
TIGHTNER
TELLURIDE
YELLOW COIN
VICTOR
BEN HUR
SUNSHINE
YELLOW CAT
LUCKY GIRL
LUCKY BOY
DECORATION
BOSTON
DESERT QUEEN
LIBERTY
JUSTICE
BULL MOOSE
MAX
STEW POT
FOX TERRIER
MAY DAY
BONE CRUSHER
WATCH DOG
TIRE
TURNER
ELK
GRAY EAGLE
ROCKY POINT
SAILOR BOY
REX
CULVER
AJAX
TIP TOP
MT. VIEW
SPRING DAY
LAST CHANCE
BLACK TIGER
GULCH EXT.

Fig. 1.

is adjacent to the Greenhorn Mountains and it adjoins the Keyes district on the west. Elevations range from 3000 to 6500 feet. The principal rocks of the district are granite and schist.

Green Mountain district is in T. 28 and 29 S., R. 34 E. and includes the territory between Piute post office on the west slope, to the edge of Kelsey Valley on the east side of the Piute Mountains. Piute is about 30 miles northeast of Caliente. In the granitic mass of this mountain there are occasional belts of schist up to four or 500 feet in width. The veins, as a rule, are narrow and the ore-shoots are short but high grade. Elevations range from 3500 to 8000 feet.

Keyes district, containing the site of the first discovery of gold in Kern County, embraces the country to the northwest of the old site of Keyesville for a distance of about five miles, in T. 26 S., R. 32 and 33 E. Isabella is the post office and it is some 35 miles north of Caliente. Granite is the predominating rock formation. The veins are narrow but high grade.

Mojave mining district is situated in a group of small hills centering around Soledad Butte. These are located four miles southwest of Mojave, the junction point of the Santa Fe and Southern Pacific railroads and include the territory in T. 10 and 11 N., R. 11, 12 and 13 W., S. B. M.

The topography presents low ranges of hills and isolated peaks of igneous or volcanic origin which rise not more than 1500 to 2000 feet above the level of the desert; the valleys which are of much greater area than the hills are typical waste-filled interior basins characteristic of the desert. Soledad Peak is about 4000 feet above sea level and about 1250 feet above the general level of the desert. A number of smaller hills are grouped south of Soledad Mountain. Bowers Hill or Exposed Treasure Butte is about one-quarter of a mile northeast of Soledad Butte and has an elevation of 400 feet above the desert.

Granite underlies the entire district. There is an exposure on the surface along the northeast flank of Bowers Hill which extends to the southwest. Rhyolite porphyry lies upon and in contact with the granite and has by far the greatest exposure of any of the rocks of the district. Rhyolite occurring in sheets and patches overlies the rhyolite porphyry and forms the summits of the small buttes.

The principal veins are on the northern flank of Soledad Mountain, on Bowers Hill and to the west of Bowers Hill on the desert plain. The veins that have been worked to any extent on the northern flank of Soledad mountain, occur in the rhyolite-porphyry and are more or less parallel, their strike being from north to N. 30° W., and dip from 80° to 60° east for a certain depth where they flatten rather abruptly. The maximum width of the veins is about 12 ft. and the minimum width 3 ft.

Beginning at the west, the principal and largest veins are the Elephant, Hope, Echo, Gray Eagle and about one mile farther east, Queen Esther, Karma and Double Standard veins. All these veins are typical quartz veins, containing quartz and minerals derived from the alteration of the wall-rock and deposited in the fissures. The pay ore is more or less irregularly distributed but it occurs in well-defined shoots or lenses, having widths of from 4 ft. to 15 ft., varying in size to 200 ft. along the veins.

On Bowers Hill there is a series of parallel veins which have a general north and south strike for a distance, then splitting in numerous branches in a northwesterly direction. The veins dip 60° east for some distance, then flatten rather abruptly to inclinations varying between 30° and 45°, growing flatter with depth, as shown in the lower workings of the Exposed Treasure mine. Here on the 900-foot level the dip of the vein is only 25°. The wall-rock of these veins for a distance is rhyolite-porphyry and then the vein follows the contact between the granite and rhyolite-porphyry. The vein filling of these lodes is quartz, granite and calcite, with soft, blackish-brown mixture of ferruginous clay and manganese dioxide. The pay ore from 4 ft. to 15 ft. in width lies in well-defined shoots or lenses, varying in length to 300 ft. The gold occurs free, associated with pyrite, chalcopyrite, with smaller amounts of galena, marcasite and sphalerite. The silver occurs as horn silver (cerargyrite) changing to argentite with depth.

The Whitmore and Yellow Dog vein systems are to the west of Bowers hill on the desert plain. The veins are more or less parallel and strike N. 30° W., dipping 45° to 60° E. Widths vary from 3 ft. to 12 ft. The veins occur on contact of granite and rhyolite-porphyry. The vein filling is similar in character to the Exposed Treasure vein system, consisting of quartz, with massive calcite and brownish-black ferruginous clay and manganese dioxide. The approximate production for the district has been over $3,000,000.

Rademacher district is an old one which has been dormant until recently. It lies in T. 28 S., R. 39 and 40 E., M. D. M., in a low range of hills at the northeast end of El Paso Mountains. This territory is some five miles north and west of Searles, a station on the Owens Valley branch of the Southern Pacific Railroad and about 15 miles north of Randsburg. Elevations range from 2700 ft. at the south edge of Indian Wells Valley to 3700 ft. at the top of the highest hill.

The country rock is granite which is traversed by numerous dikes. At the east end of the area these dikes are largely rhyolite, while to the west they are less acidic, consisting of diabase, diorite and andesite.

The veins of the district occupy what appear to be fault fractures in the granite. As a rule, they cut the dikes at large angles but a few occurrences were observed where a vein accompanies a dike for some distance, then cuts across it and follows the other wall, finally passing wholly into the granite. Considerable faulting is apparent but the amount of displacement in general was not determined. Where seen these faults displace both veins and dikes.

While sufficient work has not been done to make possible a general statement regarding width and length of ore-shoots, it is probable that they are comparatively narrow and short, but, where the dikes are numerous, may occur frequently along the strike of the vein as they appear to form at or near the intersections of veins and dikes.

The ores contain free gold associated with the oxides of iron and manganese and sulphides of iron and copper. In the granite the vein filling consists of a somewhat vitreous quartz but where the dikes are cut, the ore may be crushed dike rock partly or wholly cemented by quartz. As a rule the veins are from a few inches to four feet wide, swelling and pinching in the space of a few feet on either strike or dip.

Water is obtainable from wells in Indian Wells Valley, some 2 to 4 miles from any of the properties in the district.

Randsburg or Rand mining district includes the territory in T. 29 and 30 S., R. 40 and 41 E., M. D. M. In the center of this area is the town of Randsburg which is 45 miles northeast of Mojave and about 130 miles nearly due north of Los Angeles. Other towns in the district are Johannesburg, Atolia and Red Mountain. It is said that these are the only towns in the State whose sole industry is mining.

This is the most important mining district in Kern County. Incidentally, of the actual area mentioned above, more than half is in San Bernardino County. It includes within its boundaries the Rand Mountains, Red Mountain and Lava Mountains, the last two being entirely in San Bernardino County. The district is accessible by railroad, the Atchison, Topeka and Santa Fe having built a branch line from Kramer to Johannesburg, from Los Angeles over paved and oil roads and may be reached from any other direction over dirt roads which are kept in good repair. Good climatic conditions obtain the year around, although it is hot in the summer. Altitudes range from 2700 to 4750 ft. The elevation at Randsburg is 3500 ft.

The district as a whole is unique in that from within its boundaries and from an area of about 20 square miles there has been produced some $17,000,000 in gold, more than $16,000,000 in silver and about $13,500,000 in tungsten. Practically all of the gold came from the western portion which is in Kern County, while the silver and tungsten production is credited to San Bernardino County. Of the total production, three properties have been responsible for more than $40,000,000, namely, the Yellow Aster mine, California Rand Silver mine and Atolia Mining Company. (Only the first of these three are to be found in this report, but the other two are described in reports on San Bernardino County published by the Division of Mines.)

Topography: All of the gold mines of this district, which are in Kern County, occur on the slopes of the Rand Mountains. This range of mountains, having a northeasterly trend, rises from the desert plain to a maximum elevation of 4755 feet at the top of Government peak. From this point, which is a mile and a half southwest of Randsburg, they decrease in height both to the northeast and southwest. The north slope is quite steep, rising 1500 feet in less than two miles, whereas the south slope is gentle and uniform, requiring six miles to attain the same altitude.

Geology: (For detailed description of the geology of this area reference should be made to Bulletin 95, California State Mining Bureau, "Geology and Ore Deposits of the Randsburg Quadrangle," by Carlton D. Hulin, from which the following brief description is largely taken.)

In that portion of the district which lies in Kern County there are two principal rock formations, the Atolia quartz monzonite and the Rand schist. The bulk of the Rand Mountains is composed of the Rand schist into which has been intruded the quartz monzonite, although but few exposures of the latter are to be seen until the base of the south slope is reached.

The Rand schists are composed of the following, given in the order of their abundance: Mica-albite, amphibole and greenstone schists, with which are interbedded thin layers of quartzite and limestone. Of these, the amphibole schists, which in extreme cases may consist of practically pure actinolite, represent one end with the mica-albite schist at the other end of a series. All gradations between these two are found. The greenstone schist is supposed to be a completely recrystallized, shallow-type, intrusive rock.

The Atolia quartz-monzonite is a typical rock of its kind. It has a medium-grained, granitic texture and is composed of white and black minerals in the ratio of about five to one. The white minerals consist of orthoclase, plagioclase and quartz in approximately equal proportions. The darker constituents are hornblende and biotite in about the same amounts. It has been correlated with the Plutonic rocks of the Sierra Nevada Mountains and its probable age is that of late Jurassic.

In addition to the above, numerous rhyolite intrusions are found in the Rand Mountains. These take the form of pipes, dikes and sills. The largest of these is a pipe which forms the hill one mile southeast of Johannesburg. The dikes are of all sizes from a few inches to a hundred feet in thickness. Their age has been determined as early Upper Miocene.

Some basic dikes, either a diabase or basalt, are also to be found in the Rand Mountains but they are not nearly so numerous as the more acidic types mentioned above.

The gold ores occur in fault fissure veins and as impregnations and stockworks in both the monzonite and the Rand schist. The veins cut the dikes and are themselves frequently faulted. In no case is a dike known to cut a vein. Although they vary widely in strike, the strongest veins may be placed in two systems, one having a strike of about N. 80° E., the other northwest-southeast. All variations in dip from 20° to practically vertical are found. As a rule the veins are not very persistent, either feathering out or being cut off by faults. Some of them have well-defined walls, others, especially the flatter ones, may have only one wall, usually the hanging, the ore consisting of mineralized country rock underlying this wall.

The ore-shoots vary from a few inches to 75 ft. in width and from a few feet to approximately 800 ft. in length. The ores mined to date have practically all been oxidized. The principal minerals are quartz, arsenopyrite, pyrite, galena, gold, scheelite, iron oxides and calcite.

As mentioned above, only oxidized ores have been mined to the present time. Since there is no evidence of secondary enrichment of these oxidized ores and since such deposits are not ordinarily amenable to the chemical processes of secondary enrichment, the fact that true primary orebodies have not yet been mined may be explained by lack of discovery of such deposits. The greatest depth to which these deposits have been explored is 600 ft. in the Sunshine mine. In most instances depths of from 200 to 400 ft. only have been reached.

PLATE VII

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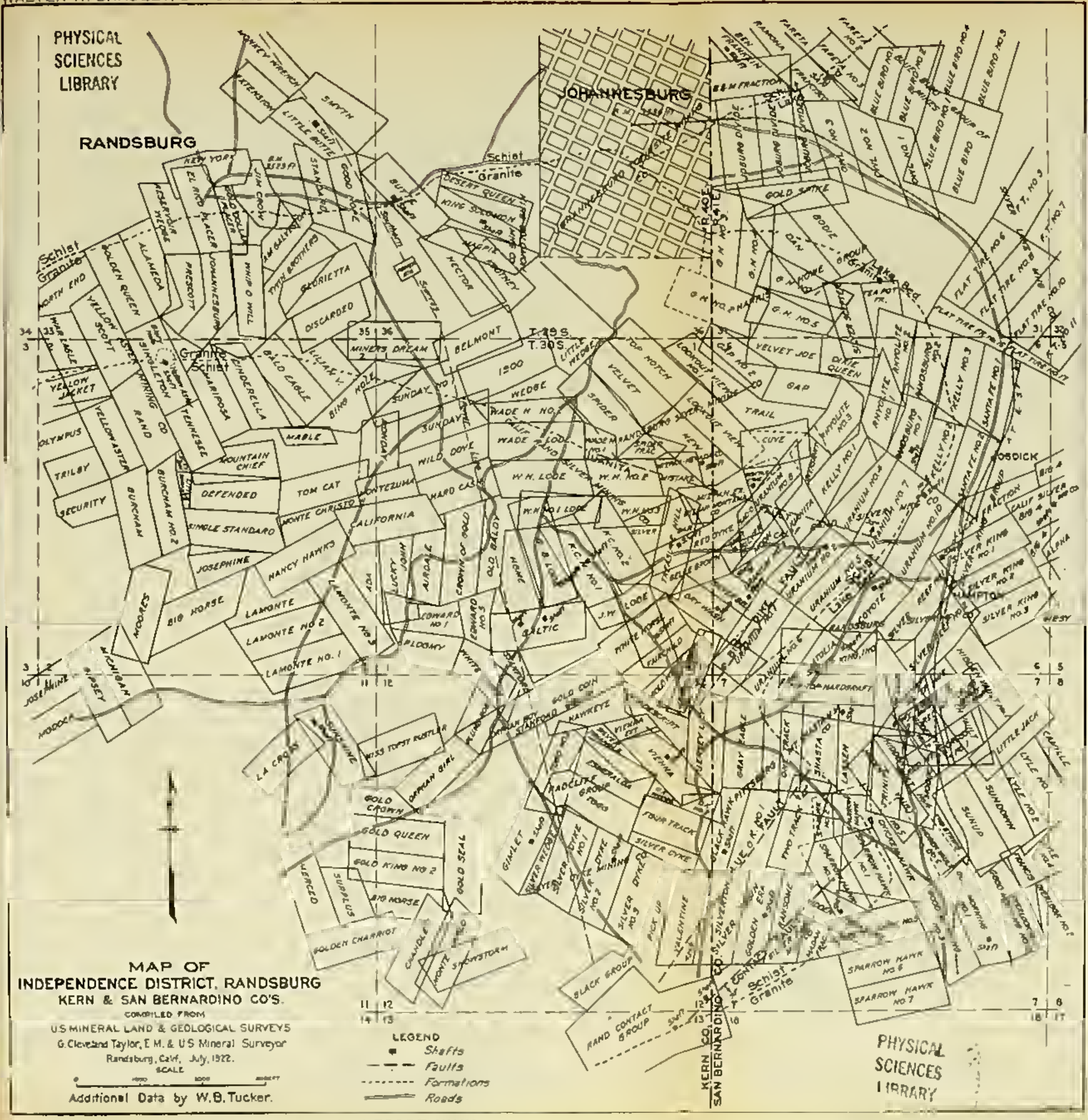
RANDSBURG
JOHANNESBURG
Schist
Granite
T.29S.
T.30S.
Lake Bed
OSDICK
HAMPTON
KERN CO.
SAN BERNARDINO CO.
Monkey Wrench
Extension
Smyth
Little Butte
New York
El Rico Placer
Jim Crow
Stanford
Good Hope
Butte
Desert Queen
King Solomon
Magpie
Hector
Alameda
Golden Queen
North End
Prescott
Johannesburg
Whip O Will
Twin Brothers
Glorietta
Discarded
Miners Dream
Belmont
Yellow Scott
Yellow Jacket
Olympus
Trilby
Security
Yellowaster
Rand
Singleton
Mariposa
Cinderella
Bald Eagle
Lillian V.
Tennessee
Burcham
Burcham No. 2
Mountain Chief
Defended
Tom Cat
Single Standard
Monte Christo
Montezuma
California
Josephine
Nancy Hawks
Big Horse
Moores
Lamonte
Lamonte No 2
Lamonte No. 1
Lamonte No 3
Michigan
Gipsey
Modoc
Sunday
Wild Dove
Hard Cash
Wedge
1900
Little Wedge
Top Notch
Velvet
Spider
Wade H No. 1
Wade H Lode
W.H. Lode
W.H. No. 2
W.H. No. 3
Mistake
Silver
Lucky John
Airdale
Crown of Gold
Old Baldy
Edward No. 1
Edward No. 3
Baltic
Home
K.C.N. No. 1
K.C.N. No. 2
J.W. Lode
Fairchild
Red Dyke
Dry Wash
Velvet Joe
Gap
Dixie Queen
Trail
Cuve
Rhyolite
Rhyolite No. 3
Johannesburg No. 1
Johannesburg No. 2
Kelly No. 1
Kelly No. 2
Kelly No. 3
Santa Fe No. 1
Santa Fe No. 2
Flat Tire No. 6
Flat Tire No. 8
Flat Tire No. 10
Flat Tire Fr.
F.T. No. 3
F.T. No. 7
Uranium No. 2
Uranium No. 4
Uranium No. 5
Uranium No. 6
Uranium No. 7
Uranium No. 10
Coyote
Silver King
Silver King No. 2
Silver King No. 3
Calif Silver
Big 4
Alpha
Hesy
Gold Strike
Dan
Bodie
G.H. No. 1
G.H. No. 2
G.H. No. 5
G.H. Howe Group
Blue Bird
Blue Bird No. 1
Blue Bird No. 2
Blue Bird No. 3
Blue Bird No. 4
Faretta
Ramona
Ben Franklin
B&M Fraction
Joburg Divide
La Crosse
Sunshine
Miss Topsy Rustler
Orphan Girl
Gold Crown
Gold Queen
Gold King No 2
Gold Seal
Merced
Surplus
Big Horse
Golden Chariot
Chandler
Monte
Snowstorm
Hawkeye
Gold Coin
Stanford Ext.
Vienna
Radcliffe Group
Esmeralda
Four Track
Silver Dyke
Silver Dyke No. 1
Silver Dyke No. 2
Silver Dyke No. 3
Giblet
Pick Up
Valentine
Black Group
Rand Contact Group
Gray Eagle
Black Hawk
Shasta
Lassen
Golden Era
O.K. No. 1
Sparrow Hawk No. 6
Sparrow Hawk No. 7
Sunup
Sundown
Lyle No. 2
Little Jack
Camille
Mable
Bing Hole
34
33
35
36
3
2
10
11
12
6
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7
8
13
14
18
17

MAP OF
INDEPENDENCE DISTRICT, RANDSBURG
KERN & SAN BERNARDINO CO'S.
COMPILED FROM
U.S. MINERAL LAND & GEOLOGICAL SURVEYS
G. Cleveland Taylor, E.M. & U.S. Mineral Surveyor
Randsburg, Calif., July, 1922.
SCALE
0 1000 2000 3000 FEET
Additional Data by W.B. Tucker.

LEGEND
- ● Shafts
- — · — Faults
- - - - - Formations
- ═══ Roads

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DESCRIPTION OF MINES AND PROSPECTS

(Alphabetically arranged, with numbers which refer to those on accompanying map of eastern portion, Kern County.)

Amalie Mine (No. 1). It comprises 21 claims, four patented, situated in the Amalie mining district, in Sec. 22, T. 30 S., R. 33 E., M.D.M., about 18 miles northeast of Caliente. Owner, Mrs. J. J. Wellboun, Caliente, California. Under lease and option to the *London Exploration Company;* Dr. Thorne R. Brandon, president; Garden of Allah Apts., Hollywood, California.

The vein occurs in quartz-porphyry, strikes northwest and dips 40° east. Width, 10 to 12 inches. Development consists of a vertical shaft 650 ft. deep with five levels, comprising over 5000 ft. of work. The property is reported to have produced $600,000.

Bibl: State Mineralogist's Reports XII, p. 141; XIII, p. 605; XIV, p. 486, XXV, p. 25.

Amy Group of Mines (Gold State) (No. 2), comprises 5 claims, situated in Sec. 5 and 22, T. 29 S., R. 34 E., M.D.M., in the Green Mountain district, nine miles north of Piute. Elevation 6250 feet. Owners, Ed George and Martin J. Errecart, Piute, California.

The property was operated by McKay and Stuter until 1898, who had a steam arrastre on the property. It is reported that the production was $75,000. The property was relocated in 1900 by M. J. Errecart, and has been operated on small scale to date. In 1931, Errecart extracted 157 tons from a winze sunk 70 feet on the vein from the upper tunnel. This ore was milled on the property and $8,900 was recovered in bullion. The average value of the ore was $56 per ton.

Six parallel veins occur in granite, strike N. 70° E., dip 70° S. Width of veins vary from 6 inches to 3 feet.

Development consists of three tunnels and some shallow shafts. At an elevation of 6335 ft., a tunnel has been driven southwest 655 ft. on the vein. At 540 ft. from the portal, a winze was sunk on the vein to a depth of 70 ft. The vein at this point has an average width of 30 inches, with an average value of $60 per ton. Ore-shoot developed on this level was 120 ft. in length and has been stoped to surface a distance of 80 ft. At 470 ft. southwest of portal, a raise connects with a crosscut tunnel 150 ft. in length, which was driven from the south side of the ridge. At an elevation of 6250 ft. a lower tunnel is being driven west to intersect ore-shoot developed in the winze from upper tunnel. This tunnel is now in 300 ft.

Mill equipment consists of 9 by 7½ in. Blake crusher, 10-ton Gibson gyratory mill, Myers concentrator, 10-h. p. gas engine driving mill equipment. Six men employed.

American Golden Eagle Mine. It is situated in the Clear Creek mining district, in Sec. 2 and 10, T. 28 S., R. 32 E., M.D.M., two miles south of Havilah. Owners, Homer Bros., Havilah, California. Idle.

Bibl: State Mineralogist's Reports XIV, p. 486; XXV, p. 25.

Baltic Mine (No. 3). It comprises 40 acres, located in the Rand district, in Sec. 1, T. 30 S., R. 40 E., M.D.M., one and one-half miles southeast of Randsburg. Elevation 3600 ft. Owner, Albert Ancker, Transportation Building, Los Angeles.

The deposit consists of many small veins of quartz in a shear zone in the schist, which is about 100 ft. in width. Two veins were worked through the Baltic Shaft which was sunk on an incline of 35°, to a depth of 160 ft. One of these veins strikes east and west, the other north and south and the veins intersect near the point where the shaft was sunk. The veins vary from 2 ft. to 4 ft. in width. About 600 ft. northwest of this shaft, a new shaft has been sunk to a depth of 610 ft. on an inclination of 65°. Levels were cut at 300 ft. and 580 ft. On the 300-ft. level a crosscut has been driven 95 ft. south, intersecting K. S. N. Vein at 55 ft. Drifts totaling 230 ft. were run on the vein. On the 580-ft. level, crosscuts were run 112 ft. to the south and 96 ft. to the north, but the vein was not encountered. The vein prospected on the 300-ft. level had a width of 2 ft. to 4 ft. but carries no commercial ore. The property is equipped with a 10-stamp mill and electrical-driven single-drum hoist. Idle.

Bibl: State Mineralogist's Reports XIV, p. 487; XXV, p. 25. Bull. 95, p. 128.

Barbarossa Mine (No. 4). It comprises 140 acres situated in the Amalie mining district, in Sec. 29, T. 30 S., R. 33 E., M.D.M., about 15 miles northeast of Caliente. Elevation 3600 feet. Owner, Mrs. J. J. Wellbaum, Caliente, California.

There are seven veins on the property; of these only the Barbarossa vein has been developed. This vein strikes northwest and dips 40° east. The vein has an average width of four feet, with a granite footwall and a quartz-porphyry hanging wall. Development consists of 140-foot shaft and 400 ft. of drifts. Idle.

Bibl: State Mineralogist's Reports XIV, p. 487; XXV, p. 25.

Barnett Mine is in Sec. 16, T. 30 N., R. 40 E., M. D. M., on the south slope of the Rand Mountains, four miles southwest of Randsburg. Elevation 3700 feet. Owner, Mrs. E. C. Randolph, 1911 Beale Avenue, Bakersfield, California. It is leased to her son, Floyd H. Barnett, of the same address. This property adjoins the White (Sidney) Mine on the east.

The vein has a quartzite hanging wall and a mica-schist footwall. Its strike is N. 60° W., dip 50° SW. The quartzite is traceable on the surface for several hundred feet and its thickness varies up to 10 or 12 ft. Free gold occurs in the silicified schist adjacent to the quartzite and in the quartzite itself or rather in a secondary quartz which has been deposited along the contact. Sufficient development work has not yet been done to make possible a statement regarding width and continuity of ore shoots. The principal development work consists of an opencut 20 ft. long, 15 ft. wide and 20 ft. deep.

Three men are employed on the erection of two 1250-lb. stamps and plates. Water is to be hauled from Randsburg.

Beehive Mine. It comprises 10 claims located 6 miles north of Randsburg, on the south slope of the El Paso Mountains. Owner, *Kern Rand Mines, Inc.*, Bakersfield, California.

The property has been developed by four shallow shafts and approximately 400 feet of horizontal workings. Idle.

Bibl: Bull. 95, 'Geology and Ore Deposits of the Randsburg Quadrangle,' p. 128; State Mineralogist's Report XXV., p. 27.

Beauregard Mine (No. 5). (See North Sumner Gold Mines.) It is situated in Cove mining district, in Sec. 28, T. 25 S., R. 33 E., M. D. M., and three-quarters of a mile north of Kernville. Owner, *Kern Development Company,* Kernville, California.

Bella Rufin Mine. It is located in Sec. 25, T. 24 S., R. 33 E., M. D. M., in the Green Mountain Mining district, about 23 miles northwest of Caliente. Owner, Herbert Gorman, Piute, California. Idle.

Bibl: State Mineralogist's Report XII, p. 142; XIV, p. 488; XXV, p. 27.

Big Blue and Sumner Group of Mines (No. 6) comprises Big Blue, Sumner, Content, Nellie Dent, Orejana, Blue Gouge No. 1, No. 2, No. 3, totaling 95 acres, situated in Cove mining district, one-half mile north of Kernville. Elevation 2900 feet. Owner, *Kern Development Company,* C. S. Long, president; C. S. Long, Jr., secretary, Hayward, California; Robert S. Long, manager, Kernville, California.

The above-mentioned claims are located on the Big Blue-Sumner lode. The Big Blue and Sumner mines were operated by the Sumner Gold Mining Company from 1875 to 1884, during which period according to records of this company, 151,000 tons of ore was milled with an average of $8.27 per ton and a total yield of $1,250,000. The records of the later production, from 1883 to 1901, mainly from leases, show over 3700 tons of ore extracted from the 240-foot level from which $13.43 per ton was recovered. The total production is reported to have been $1,746,910. R. W. Raymond in the Seventh Annual Report of the U. S. Commissioner of Mining Statistics, states:

"The Sumner produced in 1874, 5000 tons of ore with an average yield per ton of $40, total bullion produced being $200,000. The lode underground is 80 feet wide between walls and has been opened up for 1000 feet along the vein for a depth of 160 feet. The average yield was $18 per ton."

Geology and Vein Systems.

The formations consist of granite, slate and schist, the former predominating. Near the granite, a narrow bed of slate and schist extends north and south a distance of eight miles and the Big Blue-Sumner lode occupies the contact. This belt of slates and schists is one to two miles in width and 15 or more miles in length. The contact with the granite is irregular in outline and the Big Blue-Sumner vein occupies a fault which has broken through the various formations along the contact line. In places the slate and schist do not show for a considerable distance east of the Big Blue-Sumner vein. In the 3000-foot drain tunnel no slate is found as the tunnel is in granite until it strikes the Big Blue-Sumner vein where it forms part of the vein. The Big Blue-Sumner vein occupies the line of a reverse fault. The vein is of great width, vein matter and quartz showing from 80 to 125 feet in width. This lode is traceable for several miles. The main lode has generally been regarded as composed of three veins called the West or Hanging Wall vein which shows a width of 40 ft., and the East or Footwall vein, showing a width of 6 to 8 ft. The vein quartz is mineralized with pyrite, arsenopyrite, galena and spalerite. The vein filling between the veins is well silicified and somewhat mineralized with pyrite and arsenopyrite and in places, the West and Big Blue veins merge. The Big Blue-Sumner vein strikes N. 20° W. and dips 70° W.

The *Golden Center Mines, Inc.*, Charles V. Bopp, president, had the property under option from October, 1927, until the latter part of 1928, during which time the following development operations were carried on:

The drain tunnel was retimbered and extended 300 ft. into the granite hanging wall. This drain tunnel is driven N. 50° W. and intersects the Sumner shaft at 3000 ft. from the portal. At 250 ft. northwest of the shaft, a drift was driven 100 ft. north and 202 ft. south from this crosscut in the hanging wall granite. Five diamond drill stations were established in these drifts and a number of diamond drill holes have been run to prove the ore below the present tunnel level. At 2935 ft. from the portal of the main crosscut tunnel, a drift has been driven 240 ft. south in the footwall vein. At 180 ft. south of the crosscut tunnel in this drift, a crosscut has been driven 125 ft. west to hanging wall of the vein. In the face of the same drift, a crosscut has been driven through the vein to the hanging wall. The Big Blue-Sumner vein shows a width of 125 ft. in the above-mentioned crosscuts and is reported to have an average value of $5 per ton.

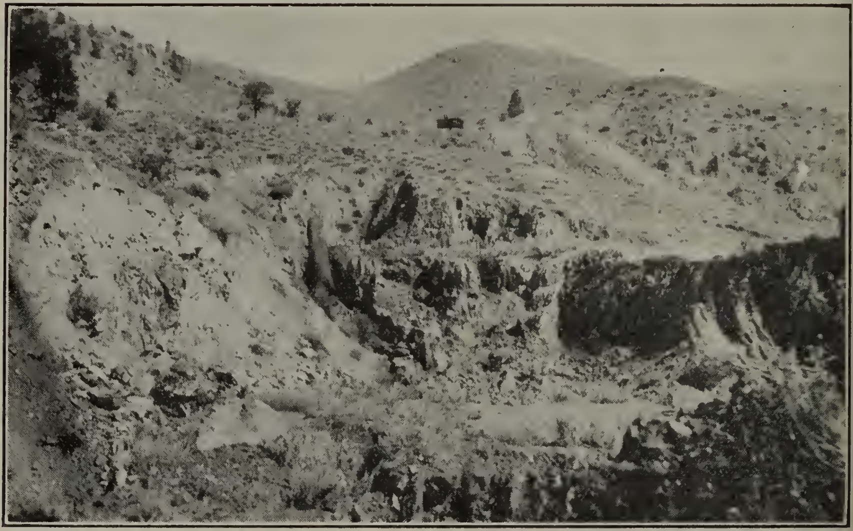

Fig. 2. Outcrop and glory hole on Big Blue-Summer Mines, Cove District, Kernville.

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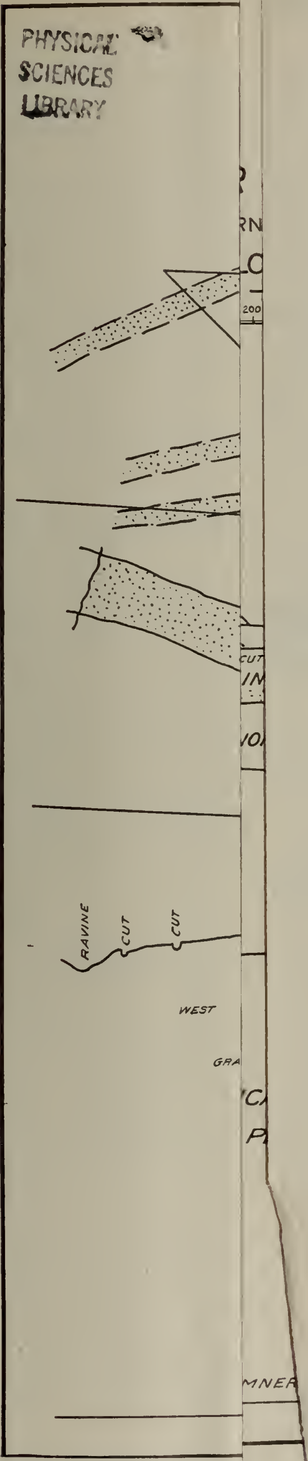
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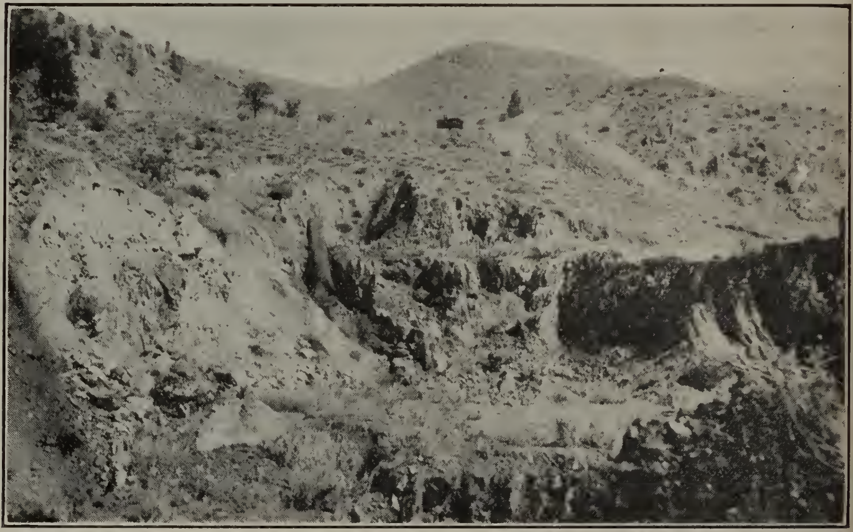

Fig. 2. Outcrop and glory hole on Big Blue-Summer Mines, Cove District, Kernville.

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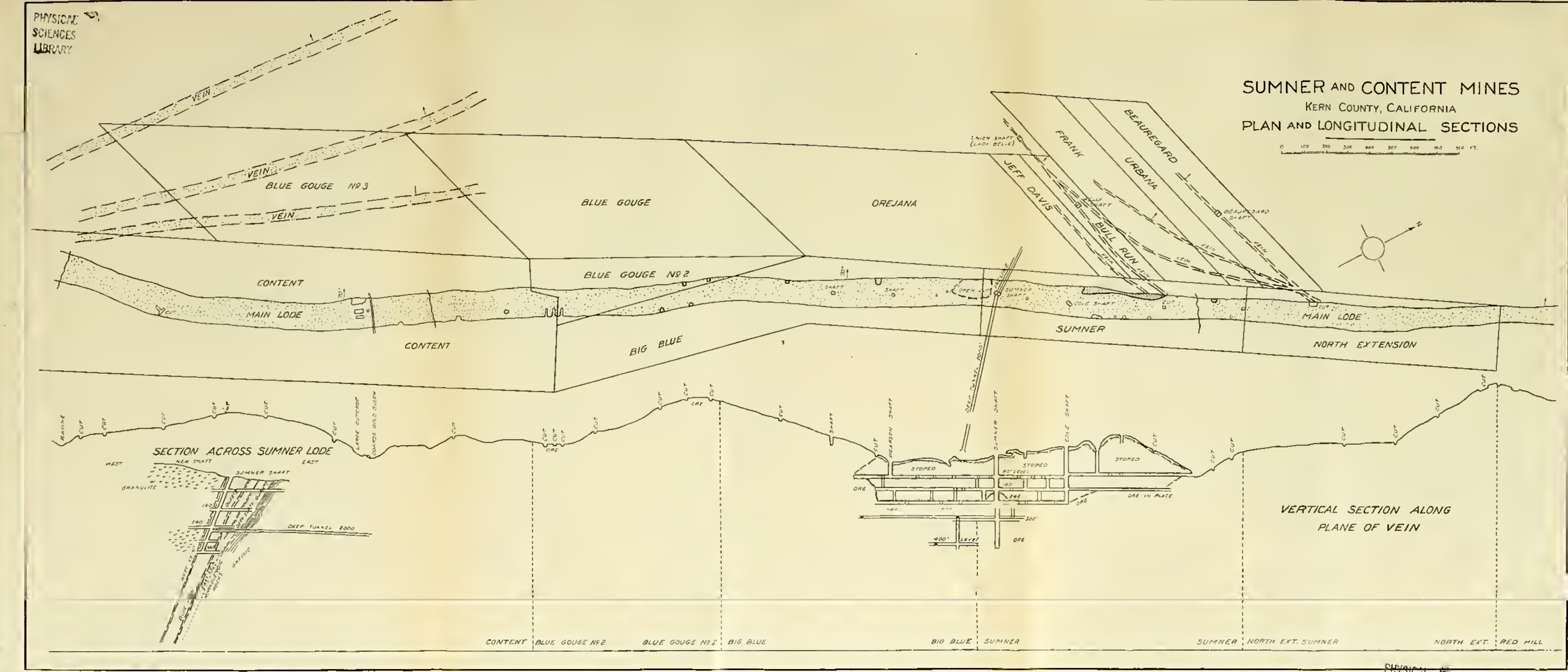
SUMNER AND CONTENT MINES
KERN COUNTY, CALIFORNIA
PLAN AND LONGITUDINAL SECTIONS


0 100 200 300 400 500 600 700 800 FT.
N
VEIN
VEIN
VEIN
BLUE GOUGE Nº 3
BLUE GOUGE
OREJANA
UNION SHAFT (LADY BELLE)
FRANK
BEAUREGARD
JEFF DAVIS
URBANA
BULL RUN
BEAUREGARD SHAFT
SHAFT
VEIN
CONTENT
MAIN LODE
CUT
BLUE GOUGE Nº 2
SHAFT
OPEN CUT
INCLINE
SUMNER SHAFT
COLE SHAFT
MAIN LODE
CONTENT
BIG BLUE
SUMNER
NORTH EXTENSION
RAVINE
CUT
LARGE OUTCROP
COARSE GOLD GULCH
ORE
DEEP TUNNEL 2000'
SHAFT
PEARSON SHAFT
SUMNER SHAFT
COLE SHAFT
STOPED
60' LEVEL
180
244
ORE
ORE IN PLACE
300'
400' LEVEL
SECTION ACROSS SUMNER LODE
WEST
NEW SHAFT
EAST
SUMNER SHAFT
GRANULITE
180'
240'
DEEP TUNNEL 2000
GNEISS
WEST VEIN
BLUE
EAST VEIN
VERTICAL SECTION ALONG PLANE OF VEIN
CONTENT
BLUE GOUGE Nº 2
BLUE GOUGE Nº 2
BIG BLUE
BIG BLUE
SUMNER
SUMNER
NORTH EXT. SUMNER
NORTH EXT.
RED HILL

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The *American Smelting & Refining Company* secured the property under lease and bond in December, 1931, and operated the property until August 26, 1932, when they surrendered their option. During this period the company put down a winze on the west vein from 260-foot level (drain tunnel level) to 400-foot level, a depth of 158 ft.; on the 400-foot level drifted south 225 ft. and north 90 ft.; on 260-foot level drifted south on the west vein 150 ft. It is estimated that recent development work has exposed 530,000 tons of ore with an average value of $7 per ton in gold. There is also reported developed on the 260-foot level 30,000 tons of ore carrying from $15 to $20 per ton in gold. The vein quartz is mineralized with pyrite and arsenopyrite. The mine makes 450 gallons of water per minute. Shipments of selected ore to the Selby smelter had an average value of $18 per ton in gold, with arsenic content of 35%. Concentrates had a value of $150 per ton.*

Bibl: State Mineralogist's Reports VIII, p. 313; XIV, pp. 488–489; XX, p. 40; XXV, pp. 27–28.

Big Butte Mine (No. 7) comprises 20 acres in Sec. 36, T. 29 S., R. 40 E., M. D. M. It is in the east end of the town of Randsburg. Elevation 3550 feet. Owner, *Butte Mining Company,* 1231 Roosevelt Building, Los Angeles.

Two veins, one to five feet wide, strike N. 70° W., dip 45° NE., are associated with a large diabase dike in the Rand schist on this property. The ore occurs in the quartz veins as lenses and as mineralized schist, largely along the footwall of the dike, although it is reported that in places the ore cuts through the dike to the hanging wall side.

The mine was developed by an incline shaft 523 ft. deep and 6500 ft. of drifts. It is reported that the production from these workings was in excess of $500,000.

The property is equipped with a 10-stamp mill and amalgamation plates. Some work is being done by leasers. The ore is treated in this mill.

Bibl: State Mining Bureau Bull. 95, p. 132; Register of Mines & Minerals Kern Co., p. 9.

Big Gold Mine (West End) (No. 8). It comprises the following claims: North Star, Crechy Strike, Neglected, Kenneth B. Fraction, totaling 74 acres located in Sec. 3 and 4, T. 30 S., R. 40 E., M. D. M., three miles southwest of Randsburg, on the west slope of the Rand Mountains, adjoining the Minnehaha Mine on the west. Owner, Patrick Spelaine and associates, Randsburg, California. Leased to John Chadima and W. J. Hennessy, 1163 East Colorado Street, Pasadena, California.

The county rock is granite and schist. A series of parallel quartz veins occur in the schist and there is also an east and west system of veins that intersect the north and south veins. The principal development work has been confined to the Big Gold vein which occurs on a fault fracture along the contact of granite and schist. This vein has a course of N. 20° W., and dips 40° E. Its average width is four feet. The quartz carries free gold and a small amount of pyrite. The croppings of the vein are prominent and can be traced for 3000 ft.

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* Since the above was written, A. V. Udell of San Francisco, and Robt. Long, Kernville, have taken over this property under lease and option; they have fifty men at work, and are planning a 200-ton mill.

Development consists of a 2-compartment vertical shaft 365 ft. deep. The shaft intersected the vein on the 155-foot level; the vein was drifted on 200 ft. south and 30 ft. north on this level. Above the 155-foot level the vein has a granite hanging wall and a schist footwall. Below this level the hanging wall is rhyolite-porphyry, with schist on the footwall. A winze has been sunk on the vein from the 155-foot level to a depth of 105 ft. Drifts have been run north and south on the vein. In 1927 100 tons of ore was extracted that milled $20 per ton.

Bibl: State Mineralogist's Reports XIX, p. 166; XXV, p. 28.

Big Dike Mine (No. 9), comprising five claims, is on the east slope of the Rand Mountains, one mile south of Randsburg. Elevation 3600 feet. Owners, Joe Shay and Ray Miller, of Randsburg. Leased to Jim Shain and Wm. Murray, Randsburg, California.

The vein, strike north-south, dip 40° E., occurs on the contact of the quartz monzonite and the Rand schist. In the present workings, the monzonite forms the footwall with the schist on the hanging. A rhyolite dike, strike east-west, occurs in both the monzonite and the schist, crossing the contact a few feet south of the shaft, where it is faulted with a displacement of about 35 ft. in a north-south direction.

Development consists of a shaft sunk on a narrow vein in the monzonite. The first 60 ft. is on a 70° incline, the last 30 ft. on 40°. On the 30-foot level a drift was driven 80 ft. south. The vein crossed the rhyolitic dike 30 ft. south of the shaft where a small lens of ore was stoped. This ore is reported to have yielded $83 per ton. On the 90-foot level a drift was driven north 60 ft. and south some 50 ft. From the face of the south drift, crosscut east 50 ft. to vein and drift north on the vein 180 ft. At 30 ft. from face of north drift there is a 20-foot winze. Apparently the north-south fault crosses the vein at this winze. The fault is post mineral, boulders of partially oxidized, sulphide ore being found in the fracture. The vein varies from a mere stringer to three feet in width. A shipment of 22 tons to the smelter averaged $31.25 per ton. Twenty tons milled on the ground yielded $13.10 per ton. Present operators estimate that there is 85 tons on the dump having an average value of $16 per ton.

The property formerly was equipped with an Ellis ball mill which has been removed.

Two men are working in winze.

Black Hawk Mine (No. 64). It comprises 130 acres, situated in the Rand district, two and one-half miles southwest of Johannesburg. The property was discovered in 1896 and operated by D. A. B. Blue until 1921, when it was purchased by the *Pittsburgh and Mount Shasta Mining & Milling Company;* J. J. Schneider, president; T. V. Scott, vice president; D. F. McCormick, manager. Offices, 516 Federal Building, Pittsburgh, Pennsylvania.

The present company started operations February 21, 1923, and the property has been under continuous development to date. Three parallel quartz veins occur in the schist, with a general north strike and dip 50° to the east. Width of the veins varies from 18 inches to 3 feet. Free-milling gold quartz; value $7 to $50 per ton. Developments: Black Hawk shaft 250 ft. deep with levels at 50, 100 and 200 ft. and 5000 ft. of drifts and crosscuts on the Black Hawk vein.

Mine equipment: At Black Hawk shaft, there is a 20-h.p. direct connected electric hoist; at Pittsburgh shaft, a 50-h.p. electric hoist and 12 by 10-in. compressor; at the Bevis Divide shaft, a 25-h.p. electric hoist.

Mill equipment: 5 stamps, weight 1000 pounds. The ore is crushed through 40-mesh, followed by amalgamation. Mine is idle; mill is operated on custom ores.

Total production of Black Hawk is about $400,000. Three men are employed.

> Bibl: State Mineralogist's Reports XIX, pp. 166–167; XIV, p. 489; XXV, p. 29. Bull. 95, 'Geology and Ore Deposits of the Randsburg Quadrangle,' pp. 130–131.

Bowman Mine (No. 65). It comprises three claims situated in Sec. 20, T. 28 S., R. 34 E., M. D. M., one mile north of French Meadows and 8 miles north of Piute, in the Green Mountain mining district. Elevation 7100 feet. Owners, J. W. Walters, of Isabella, and A. O. Griswald, Piute, California. Under lease and bond to J. A. Neilson and R. Buckner, of Bakersfield, California.

The vein which occurs in granite strikes N. 70° E. and dips 70° S. Width varies from 6 inches to two feet. Vein quartz shows free gold with pyrite and marcasite. Ore reported to have average value of $40 per ton in gold.

Development consists of tunnel driven on the vein N. 70° E. 650 ft. At 100 ft. from portal first shoot of ore was cut which was 150 ft. in length and stoped to surface. At 500 ft. from portal, there is a raise on second ore-shoot which connects with shaft from surface a distance of 200 ft.

Ore-chutes are being installed to start stoping operations on this second ore-shoot.

Mill equipment consists of three 1000-lb. stamps, 20-h.p. boiler and 15-h.p. Atlas steam engine.

Two men are employed.

> Bibl: State Mineralogist's Report XIV, p. 512.

Blue Mountain Mine (Dreadnot) (No. 11). It comprises 170 acres located in Sec. 11, 12 and 14, T. 25 S., R. 29 E., M. D. M., in Woody mining district, 6 miles southwest of White River. Elevation 3600 feet. Owner, Blue Mountain Mining Company; J. W. Howard, president; Rodney McCormick, secretary, Bakersfield, California. Under lease to Hugh Moore, White River, California.

Two parallel veins occur in the granite, strike NE. and SW., dip 45° S. Workings consist of shaft 450 ft. deep. Three levels and 4000 ft. of drifts. The vein quartz carries free gold and pyrite. Width of veins 12 inches to 2 feet.

Mine equipment consists of hoist and dwellings. Reduction equipment consists of 5-stamp mill. Production $75,000. Present lessee has milled a few tons of ore. Three men are employed.

> Bibl: State Mineralogist's Reports XII, p. 143; XIII, p. 187; XIV, p. 143; XXV, p. 31.

Bond Buyer Group of 10 claims is in Sec. 1, T. 30 S., R. 37 E., M. D. M., 25 miles north of Mojave and three miles from Cantil, a station on the Owens Valley branch of the Southern Pacific Railroad. Elevation about 2500 feet. Owner, J. D. Voss, Saltdale, California.

It is reported that a series of veins has been exposed by open-cuts on this property. The strike of the mineralized zone is northwest-southeast, with a steep easterly dip. The veins carry values in copper, silver and gold.

Idle except for assessment work.

Broken Axel Group of four claims is on the north slope of th range of hills at the northeast end of El Paso Mountains, in th Rademacher district. They are four miles north of Searles Statio Owner, R. Salisbury, Lancaster, California, who is prospecting ground.

Bryan Mine (No. 66). It comprises five claims situated in Sec. 19, T. 29 S., R. 34 W., M. D. M., on ridge south of Kelso Valley, in Piute mining district, 8 miles east of Piute. Elevation 5500 feet. Owners, Donald C. Fugitt, El Segundo, California, and Domico Domenghini, Piute, California.

The vein occurs in granite, strike NW. and SE., dip 10° to 15° SW. Width varies from 12 inches to 4 feet. From the dip of the vein and the broken character of the country rock, the vein appears to be in block of ground that has moved from the top of the ridge.

Development consists of a crosscut tunnel driven southwest 600 ft. to the vein, with a drift northwest 275 ft. on the vein. These workings connect with a tunnel driven southeast 300 ft. on the vein from the north side of ridge. At 92 ft. in elevation below this tunnel, there is another tunnel driven southeast 400 ft. There are two raises connecting with upper workings, one at 200 ft. from the portal is 92 ft., the other at 400 ft. from portal is 75 ft.

Mill equipment consists of five 1000-lb. stamps; 15-h.p. Atlas steam engine and 20-h.p. boiler.

Two men are employed.

Buckboard Mine (No. 12), comprising 6 claims, is on the south slope of Government Peak in the Rand Mountains, two and one-half miles southwest of Randsburg. Elevation about 4000 feet. Owner, Albert Ancker, Transportation Building, Los Angeles. Under lease to Snow and Moody, Pantages Theater Building, Hollywood, California, who have incorporated under the name of *Randsburg Gold Mines, Ltd.*

This mine, one and one-half miles south of the Yellow Aster, is in the Rand schist which has here been intruded by several rhyolite dikes. The principal one of these dikes is from 15 to 50 feet thick. Its general strike is N. 30° W., dip 45° NE. The main vein, filling a fault fracture in the schist, strikes east-west, with a variable dip which probably averages about 50° to the north. There is also a series of hanging wall fractures, strike north-south, with dips to either east or west. These form junctions with the main vein but apparently do not cross it. There is also a vein or mineralized zone along the footwall side of the dike. The vein filling along the dike consists of silicified and mineralized dike rock and as now exposed, in the mine, its width varies up to 6 or 7 feet. No crosscut has yet been driven to the hanging wall side of this dike.

The mine has been developed by three inclined shafts. The original shaft was sunk to a depth of 165 ft. on the vein. It is no longer accessible. The main shaft is 450 ft. long and it reaches a vertical depth of 205 ft. below the collar. The east shaft, 350 ft. east of the main shaft, was sunk on the vein and at the bottom it connects with the 250-foot level of the main shaft.

In the main shaft levels were driven at 100, 150, 200, 250, 350 and 450-foot horizons. A total of 1550 ft. of drifts and crosscuts have been made. This shaft was sunk very close to the intersection of the vein with the dike and the last 100 ft. is practically in the dike. An ore shoot about 150 ft. long by 2½ to 4 ft. wide was stoped from the 200 to the 150-foot level. There are several other smaller stopes in the mine. These shoots occur near the dike intersection, the principal one being about 50 ft. west of this intersection.

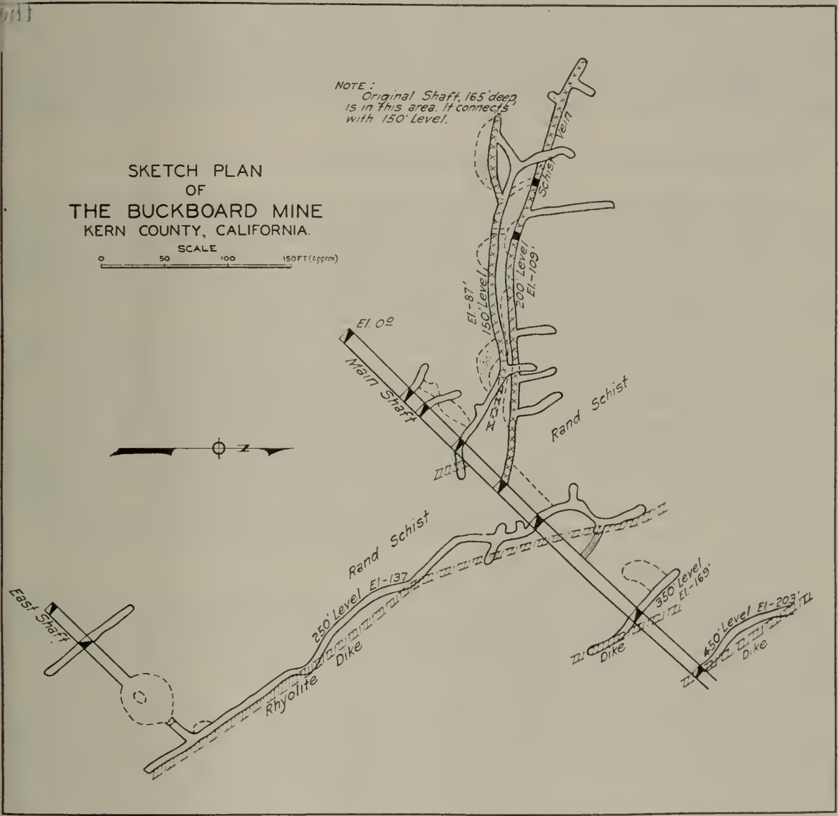
NOTE: Original Shaft, 165' deep is in this area. It connects with 150' Level.
SKETCH PLAN
OF
THE BUCKBOARD MINE
KERN COUNTY, CALIFORNIA.
SCALE
0
50
100
150 FT (Approx)
Vein
Schist
El-87'
150' Level
200' Level
El.-109'
El. 0º
Main Shaft
Rand Schist
Rand Schist
250' Level El-137'
Dike
Rhyolite
East Shaft
350' Level El-169'
Dike
450' Level El-203'
Dike

FIG. 3.

Production from these workings is reported to have been $300,000. It is also reported that estimates show some 80,000 tons of ore remaining in the mine having an average value of $5 per ton.

Idle except for assessment work.

Burning Moscow Mine (No. 13). It comprises 12 claims situated in Sec. 19, T. 28 S., R. 35 E., M. D. M., on the west slope of Piute Mountains and on ridge south of Kelso Creek, in Sageland mining district, 10 miles northeast of Piute. Elevation 5400 to 5700 feet. Owner, *Piute Mining Company,* William J. Quackenbush, president and general manager, Bakersfield, California.

The vein occurs in granite, strike N. 70° E., dip 60 to 70° S. The width varies from 2 to 4 ft. Vein quartz shows free gold with pyrite and marcasite.

Development: At an elevation of 5400 ft. on slope of ridge above Kelso Creek, a crosscut tunnel has been driven S. 30° W. 550 ft. intersecting the vein at a depth of 250 ft. below collar of incline shaft, which was sunk on the vein to a depth of 150 ft. The vein on tunnel level is five feet in width and reported to have values of $10 to $20 per ton in gold. At present they are drifting east and west on the vein. West drift is 200 ft. west of crosscut. East drift is 200 ft. east of crosscut.

Equipment: Le Roi 12-h.p. hoist; portable Sullivan compressor; blacksmith shop and dwellings. Mill equipment consists of four 1000-lb. stamps.

Seven men are employed on development.

Castle Butte Mine (Lost Cabin Mine). It comprises 6 claims situated in Sec. 24, T. 29 S., R. 34 E., M. D. M., on ridge north of Cottonwood Creek, near Lee spring, in Piute mining district, five miles northeast of Piute. Elevation 6000 to 6600 feet. Owners, Lee Orrell, J. N. Harvey and George Purvis, Bakersfield, California.

The vein occurs in granite, strike NE. and SW., dip 70° S. Width is 2 ft. to 4 ft. There is also a vein which strikes north and south, dip 70° W., which intersects the northeast vein below Lee Cabin.

Development consists of a number of tunnels driven at different elevations on the vein from 50 to 150 ft. in length; also shaft near top of the ridge 50 ft. deep. They are at present driving lower tunnel on the vein which is in a distance of 60 ft. The vein shows a width of three feet. Vein quartz is mineralized with pyrite and marcasite.

Three men are employed.

Claraville Placers (No. 68). These gold placers are situated on the headwaters of Kelso Creek in Sec. 27, 34, T. 28 S., R. 34 E., and Sec. 4, T. 29 S., R. 34 E., M. D. M., at Claraville and 6 miles north of Piute. Elevation 6200 feet.

These placers have been worked on the east fork of Kelso Creek in the vicinity of Landers Meadows for a distance of one and one-half miles and on the west fork for a distance of one mile west of Claraville. The bank along these streams is from 6 ft. to 15 ft. in height and the area worked is from 100 to 200 ft. in width. Bedrock is granite. The gold in the stream comes from stringers and quartz veins in the immediate vicinity of the creek. A. V. Fulton, of Cantil, has installed sluices and has been operating for a year with fair returns. The gold recovered is fine with some small-sized nuggets.

Two men are employed.

Confidence Group of 6 claims is some 25 miles north of Mojave and about four miles from Cantil, a station on the Owens Valley branch of the Southern Pacific Railroad. Owner, J. D. Voss, Saltdale, California.

It is reported that there is a wide, mineralized zone on these claims. This zone is on the contact between andesite and limestone and schist. While predominating values in the widest portions consist of zinc and lead, it is reported that the narrower veins carry good values in gold, silver and lead.

Development work has been largely confined to trenching the surface.

Idle except for assessment work.

Consolidated Mines (No. 14.) It comprises 120 acres, patented, located in Sec. 35, T. 29 S., R. 40 E., M. D. M., one mile west of Johannesburg, in Rand mining district. Elevation 3550 feet. Owner, Consolidated Mines Company; W. H. Herren, president; John Brock, secretary, 1402 South Wilton Place, Los Angeles.

Two veins, the Good Hope and Butte, strike east and west, dip 56° south. Average width is 20 inches. Workings consist of shafts 300 ft. deep with five levels and several thousand feet of drifts. Mine equipment consists of electric hoist. Mill equipment consists of 5-stamp mill. Idle.

Bibl: State Mineralogist's Reports XIV, p. 496; XXV, p. 31.

David King and Tango Group of Mines. These claims are situated in Green Mountain mining district, in Sec. 10, T. 29 S., R. 34 E., M. D. M., southeast of Landers Meadows and six miles northeast of Piute. Elevation 6500 feet. Owner, Jess Arants, Roscoe, California.

Vein occurs in granite; strike NE. and SW., dip 60° S.; width 6 to 18 inches.

Development consists of a number of shallow shafts 50 ft. to 60 ft. deep and two tunnels, one 50 ft. in length, the other 130 ft.

In gulch below main outcrop about one-quarter of an acre of ground has been placered and reported to have produced several thousand dollars. Water for placering pumped from Kelso Creek through three-inch pipeline a distance of 2000 ft.

Two men are employed in driving lower tunnel.

Dead River Channel Placer (No. 69). It comprises 40 acres in Sec. 17, T. 26 S., R. 33 E., M. D. M., one-half mile north of Isabella. Elevation 2500 feet. Owner, Charles Gibson, Isabella, California.

This gravel was worked in 1890 by Steve Barton, of Isabella, by sluicing. The channel is about 300 ft. wide and 6 ft. to 8 ft. in depth, and occurs along a small tributary to the Kern River, which runs east and west. Bedrock is granite. Pay gravel is reported to have an average value of 50 cents per cubic yard. Under lease in 1931 and 1932 to C. H. Wood, Glendora, California.

Equipment consists of steam shovel with ¾-yard dipper, screening and washing plant.

Idle.

Dearborn Mine (No. 70). It comprises four claims situated in Sec. 36, T. 29 S., R. 34 E., M. D. M., six miles east of Piute, on ridge west of Cottonwood Creek, in Piute Mountains. Elevation 5400 feet. Owner, Otto and Jack Geringer, Chicago, Illinois.

The vein strikes NE. and SW., dip 40° S.; width 8 to 12 inches. The formation is granite.

Development consists of incline shaft 40 feet deep.

Idle.

Drunkards Dream Mine (No. 58). It comprises 8 claims situated in the Clear Creek mining district, in Sec. 17 and 18, T. 28 S., R. 33 E., M. D. M., on ridge between Clear Creek and Haight Canyon, 2½ miles east of King Solomon mine and 4 miles from Havilah. Elevation 7000 feet. Owners, J. L. Stubblefield, E. A. Rosa, Havilah, California. Under lease and bond to J. C. Walsher and associates, Bakersfield, California.

This is a new discovery made in March, 1933, by J. L. Stubblefield, who found some rich float on the slope of ridge above Haight Canyon and after doing some trenching, discovered the vein which did not outcrop.

Three parallel veins occur in the granite which strike N. 70° E. and dip 60° NW.; width varies from 2 ft. to 4 ft. These veins are from 50 to 100 ft. apart and the most southerly vein is the one being developed, while the most northerly vein is probably the King Solomon Lode.

Development consists of a crosscut tunnel driven N. 40° W., 170 ft. to vein and which is 100 ft. in elevation below incline shaft sunk to a depth of 25 ft. on the vein. Open-cuts and shallow shafts have been made along the vein for a distance of 450 ft. Samples taken from different open-cuts and shafts carry from $43 to $100 per ton in gold. Twenty tons of ore sacked from different workings is stated to have an average value of $75 per ton. Eight men are employed in building sled road from King Solomon mine to the property and also sinking shaft and sacking ore. It is planned to mine 100 tons of ore which is to be milled at John Hooper's custom mill at Hobo Hot Springs. George L. Ramey, of Caliente, is superintendent.

Echo and Gray Eagle Mines (No. 15). It comprises 6 claims totaling 120 acres, 60 acres of which is patented, located in Sec. 6, T. 10 N., R. 12 W., S. B. M., four miles south of Mojave, in the Mojave mining district. Elevation 3500 feet. Owners, A. Asher and Bert Fisher, Mojave, California.

There are three parallel veins on the property known as the Echo, Starlight and Gray Eagle which occur in rhyolite-porphyry. The general course of these veins is northwest and they dip to the northeast. The outcrop of the Echo vein can be traced on the surface for 1800 ft. and throughout its entire length it has a width of four feet. The gold occurs free associated with pyrite. The silver occurs as hornsilver (cerargyrite), changing to argentite in depth. The average value of the ore is reported to have been $9 per ton, 60% of which was gold and 40% in silver. The ore-shoots in the vein occur in irregular lenses which have a length of 100 ft. to 200 ft. The Starlight vein is about 300 ft. east of the Echo vein, is parallel to its strike and dips to the northeast. Average width is three feet. It is reported this vein carried a high silver content. The Gray Eagle vein commences near the northern end of the Starlight vein, diverging from it in a southerly direction but finally runs parallel to it. The dip is almost vertical and the average width about three feet.

Underground workings: At an elevation of 3100 ft., No. 1 Echo tunnel is driven N 25° W., 230 ft. to the Starlight vein and the vein drifted on 980 ft. to the southeast. At 175 ft. above this tunnel there is a drift run on the Gray Eagle vein 900 ft. to the point where it came in contact with the Starlight vein. Gray Eagle tunnel is a crosscut southwest 180 ft. to the Gypsy vein, with drift on this southeast 640 ft. Elevation of Gray Eagle tunnel is 3275 ft. Upper Starlight tunnel is driven 780 ft. southeast on the Starlight vein. It is reported that a pay shoot 240 ft. in length was developed on the Gray Eagle vein, the width being from 4 ft. to 15 ft. These veins have been stoped to the surface above the tunnel levels. The property was formerly operated by the *Echo Consolidated Mining Company,* the ore being treated in a 10-stamp mill, which plant was dismantled in 1906. The mine is reported to have a production record of $200,000 to $400,000. Ten leasers working. Ore treated in Elephant mill.

Bibl: State Mineralogist's Reports XIX, pp. 158–159; XXV, pp. 31–32.

Ederl Group of Mines (No. 60). It comprises 15 claims situated in Sec. 4, 9 and 10, T. 28 S., R. 32 E., M. D. M., in the Clear Creek mining district, one mile west of Havilah. Elevation 3775 to 4500 feet. Owner, Ederl Mines, Ltd.; Earl E. Lambert, president; Louis A. Elder, secretary, 1417 West Pico Street, Los Angeles.

This is a consolidation of a group of old mines known as the McKeadney, Ophir and Venus which were operated in the early 70's and relocated in 1921 by E. W. West, of Havilah. The present company was incorporated in 1929 and operated the property from 1929 to 1932.

The principal development work is confined to McKeadney, Ophir and Venus system of veins. A series of parallel veins occur in the granite, strike northeast and southwest, dip 70° to 80° SE. These veins vary from 12 inches to 4 feet in width and occur along shear zones in the granite. On the McKeadney (Delphi) vein at an elevation of 4200 ft., a tunnel has been driven southwest 500 ft.; at 400 ft. from portal cut ore-shoot which has been stoped for a distance of 200 ft. to the surface. Also a winze was sunk from tunnel level to depth of 40 ft., with drift 200 ft. southwest, also stoped and shaft 230 ft. deep.

The vein quartz is mineralized with pyrite and arsenopyrite. On the northwest end of the Ophir claim, a crosscut tunnel was driven N. 55° W. 900 ft., it being the intention of former operators to cut the McKeadney ore-shoot at a vertical depth of 450 ft. but the tunnel was never completed. The total distance to be driven to intersect the McKeadney vein is about 1700 ft. The Ophir vein has been developed by a number of crosscut tunnels driven to the vein a distance of 100 ft. to 150 ft. with glory holes and open-cuts along the vein; also tunnel on vein 400 ft. long and 600 ft. of drifts. Ore milled from these workings was oxidized and at 50 ft. to 75 ft. below outcrop, encountered sulphide zone, the vein quartz being mineralized with pyrite and arsenopyrite.

On Venus claims there are three tunnels. The lower tunnel is driven southwest 100 ft. and then west 600 ft. There are two upper tunnels each 150 ft. in length and a shaft 100 ft. deep. Ore occurred on intersection of northeast fractures with east and west fractures.

Mill equipment consists of 7 in. by 10 in. Blake crusher, steel ore bin capacity 15 tons; ½-in. material from ore bin to Ellis mill driven by 6-h.p. gas engine. Material is ground to 40-mesh, then over amalgamation plates to four Service concentrators which are driven by 3-h.p. gas engine. Mill has a capacity of 15 tons per 24 hours. Water for mill from main crosscut tunnel to three galvanized tanks having a capacity of 11,000 gallons.

Three men are enployed.

Bibl: State Mineralogist's Reports XIV, pp. 503–506; XIII, pp. 193–194; XXV, pp 41 and 44.

Elbow and Boulder placer claims are on the Kern River about one and one-quarter miles above Democrat Hot Springs and some 25 miles northeast of Bakersfield.

For several months in 1931, H. D. Smith, W. M. Campbell and L. M. Duncan here worked an American sand pump, together with dragline and water pump, washing gravel from the bottom of the river.

Elephant Group of Mines (No. 16). It comprises approximately 100 acres located in Sec. 6, T. 10 N., R. 12 W., S. B. M., about five miles south of Mojave. Elevation 3000 feet. Owner, E. G. Staples, Mojave, California.

Three roughly parallel veins, known as Hope, Excelsior and Elephant, have been developed on the property. These veins have a general northwest strike, with dips varying from 50° to 80° to the northeast. The veins occur in silicified rhyolite-porphyry. The vein material is highly brecciated, containing quartz and including silicified porphyry, which is stained with iron oxide. The veins vary in width from 3 ft. to 7 ft.

Workings on Elephant vein consist of a shaft 300 ft. deep, sunk on an incline of 70°, with levels at 100, 200 and 300 ft. The Excelsior vein is developed by a shaft of 150 ft., sunk on the vein, which has a dip of 55°. The vein strikes N. 20° W. and has an average width of three feet. The vein has been drifted on the 50 and 150-foot levels for a distance of several hundred feet and stoped to the surface. The Hope vein, which has a strike of N. 20° W., dips 70° east. Average width is two feet. This vein has been developed by a tunnel a distance of 400 ft. Ore is trammed from Hope and Excelsior workings over a tramline 2500 ft. in length to the mill below Elephant shaft.

Mine equipment: At Elephant shaft, equipment consists of 25-h.p. single-drum electric hoist, 300-cu. ft. Chicago pneumatic compressor, driven by 100-h.p. motor and transformers. Electric power is secured from the Southern California Edison Company.

Mill equipment: Marcy ball mill; 25-ton cyanide plant.

Six men are employed. Leasers are shipping to Tropico Mill.

Bibl: State Mineralogist's Reports XIX, p. 159; XXV, pp. 32–33.

Esperanza Mine (No. 72). Comprising 10 claims, is in the Sageland mining district on the southwest slope of the Piute Mountains, three miles northeast of Doyle's ranch and 22 miles west of Weldon. It is on the northeast side of Kelso Valley at an elevation of 5000 feet. Owners, Wm. Carpenter, of Pomona, and Howard Wood, Box 237, Mojave, California.

The vein in the granodiorite strikes NW.-SE., dips 45° SW. Its width varies from 6 inches to 3 feet and is reported to average 20 inches in the ore-shoots.

Development consists of three tunnels, two of which are caved. The upper tunnel is at an elevation of 5100 ft. and is 350 ft. long. At an elevation of 5000 ft. a 700-foot tunnel was driven. Both of these are now inaccessible. Present working tunnel was started at an elevation of 4850 ft. It is driven in a northwest direction. The first 170 ft. is a crosscut to the vein, with a 300-foot drift on the vein. Most of the drift is timbered and lagged. The vein shows from 6 inches to 3 feet wide. It is reported that three ore-shoots were developed in the upper tunnels, 40, 60 and 100 ft. long, having an average width of 20 inches and carrying $15 per ton. The values occur as free gold and in the iron sulphides. It is believed that the present tunnel will have to be driven about 50 ft. further to pick up the first ore-shoot.

Equipment consists of 118 cu. ft. compressor and 30-h.p. gas engine which also drives the mill. Mill equipment: 4-in. by 6-in. Blake type crusher, 10-ton bin, 3-ft. Herman ball mill, plates and two Service concentrators. There is also a 220-cu. ft. compressor on the ground.

Water is obtained from the mine and a spring through 3500 ft. of 2-in. and 4-in. pipe.

Reported production of $26,000.

Three men are working in lower tunnel.

Bibl: State Mineralogist's Report XXV, p. 33.

Exposed Treasure and Desert Queen Mines (No. 17). The largest producer in the Mojave mining district comprises 100 acres of patented ground and 60 acres held by location, located in Sec. 32, T. 11 N., R. 12 W., S. B. M., about three and one-half miles south of Mojave, on Bowers Hill. Owner, Gordon Gray, Bank of America Building, San Diego, California. Under lease to Clifford Burton, Tropico, California. Leasers ore is milled at Tropico Mines.

Seven parallel veins have been developed on the property of which the most productive have been the Exposed Treasure, Desert Queen and Yellow Rover. The principal development work has been confined to the Exposed Treasure and Desert Queen veins. These veins have a general north and south strike but split in numerous branches which strike N. 30° W. The veins near the surface have a dip of 60° for a certain distance with depth, as the Exposed Treasure vein on the 900-foot level has a dip of only 25° to the northeast. The veins have widths varying from 4 ft. to 15 ft.

Workings consist of shafts on the different veins. On the Exposed Treasure vein an incline shaft has been sunk to a depth of 900 ft. with levels at intervals of 100 ft., with over 10,000 ft. of drifts and stopes. On the Desert Queen vein a shaft has been sunk to a depth of 400 ft. on a 70° incline, with levels at 100, 200, 300 and 380 ft. The vein has an average width of three feet, with a granite footwall and rhyolite-porphyry hanging wall. The most recent development has been a crosscut from 380-foot level of the Desert Queen shaft, intersecting the Exposed Treasure vein 900 ft. west of the Desert Queen shaft and at a depth of about 135 ft. below the 900-foot level of the Exposed Treasure shaft. A very heavy flow of water was encountered in this crosscut.

Due to the cost of handling this flow of water and also to a disastrous fire which destroyed the mill and surface plant, operations were suspended in the latter part of 1928.

Mine equipment consists of 30-h.p. electric hoist, Ingersoll Rand compressor, air drills, five Byron-Jackson pumps driven by electric motors, located at Desert Queen shaft. Electric power is secured from the Tehachapi Mountains, a distance of 18 miles through the Soledad pipe line, which is owned by the company. The production record to date is over $2,000,000. Fifty leasers employed.

Bibl: State Mineralogist's Reports XIX, pp. 160–161; XIV, pp. 493, 504–505; XXV, pp. 33–34. Transactions Am. Inst. Min. Engineers Vol. XXXVIII, pp. 310–319.

Fine Gold Group (*Placer*) (No. 18). Consisting of one full claim and two fractions, comprising 33 acres, is in Goler canyon, one-half mile above its mouth. Owners, C. A. Irvine and W. A. Patterson, Lancaster, California. Under lease to R. A. Watson, of Randsburg and Claire E. Beckett, Eagle Rock, California. Subleased and optioned to Fine Gold Group, M. S. Kingston, Eveleth, Minnesota; Frank E. Sutton and C. H. Sebenius, 858 Adelaide Drive, Pasadena, California.

The depth from the floor of the canyon to the diorite bedrock is from 55 ft. to 60 ft. This material is mixed sand and gravel. In some places a gravel bed about 25 ft. thick is found but as a rule the best values are found on the deep bedrock. The pay gravel is from a few inches to about three feet thick. The gravel is of fairly uniform size, with occasional bunches of boulders, the largest of which weigh 2 or 3 tons. On the east side of the canyon is a narrow bench, some 10 ft. above the real bottom bedrock, from which most of the values are now being taken. The pay gravel is reported to average $5 to $6 per yard; individual nuggets up to $40, many pieces of $5 and $6 value.

Developed by well-equipped shaft, 61 feet to bedrock, with about 500 ft. of drifts. Workings lighted by electricity. Three-quarter k w generator run from the 9-h.p. gas engine hoist.

Nine men working.

Gem Mine. It comprises 8 claims situated on the ridge south of Kern river, 28 miles southeast of Bakersfield, in the Democrat mining district. Elevation 2800 feet. Owner, John Wilson Estate, of San Francisco, California. Under option to Carl Haney; Quay Griggs and associates, Bakersfield, California.

The formation is granite. The vein varies from 12 inches to 4 feet in width. The strike is northeast and southwest, with dip 45° southeast.

Workings consist of a crosscut tunnel driven S. 20° E. 650 ft. to the vein, with a drift northeast 60 ft. and southwest 200 ft. on the vein. At 550 ft. from the portal of the tunnel, a raise has been put up on an incline of 45° in the footwall, a distance of 90 ft. to intersect the vein. At this elevation above main crosscut tunnel, a drift has been driven on the vein 110 ft. to the northeast and at 75 ft. from the raise, encountered a shoot of ore. The vein has an average width of four feet and is said to carry from $8 to $20 per ton in gold for a distance of 45 ft. About 200 ft. in elevation above the lower crosscut tunnel, there is another tunnel driven south 100 ft. to the vein, with stopes to the surface. The total production is reported to have been $30,000.

The property is equipped with 1-drill, Sullivan compressor, cars, blacksmith shop and 5-stamp mill.

Three men employed.

Bibl: State Mineralogist's Report XXV, p. 34.

Gold Bug Mine (No. 20). Comprising 9 claims, is in the Rademacher district, five miles north of Searles, a station on the Owens valley branch of the Southern Pacific Railroad. It is on the north slope of a range of hills at the northeast end of El Paso Mountains. Elevation about 3500 feet. Owner, A. DeMayo, Searles Station, California.

This property was discovered in the nineties and worked until about 1900. It was relocated by DeMayo in 1928.

The country rock is granite. The main vein strikes N. 30° W., dips 70° NE. The vein cuts a diorite dike at an angle of about 30°. The ore forms at this intersection. Vein is faulted both north and south of main shaft. The faults strike N.-S. and N.65°W. and are practically vertical. There is another vein with a more westerly strike which appears to intersect the main or Gold Bug vein, some 300 ft. southeast of the Gold Bug shaft.

The main vein varies from about 18 inches to 8 feet in width and averages approximately 2½ ft. Judged from stopes in the workings, the ore shoots are short, from 30 ft. to 50 or 60 ft. The principal values are in free gold, the presence of which is indicated by the oxides of iron and manganese.

Principal development consists of three shafts. The Gold Bug is sunk on a 70° incline for 300 ft.; the Mountain Lion 60 ft. on 45° incline; the One Man shaft 105 ft. on 70°.

Development in Gold Bug shaft: 20-foot level, drift south 20 ft.; 40-foot level, drift north 60 ft. There is a 25-foot raise 20 ft. from the shaft and a winze in face of drift. Drift south 60 ft. shows ore-shoot 40 ft. long, 2 ft. to 3 ft. wide, faulted by north-south fault, vertical; striations on the wall rake 45° to north.

On 100-foot level: Drift N. 150 ft., 35 ft. from shaft, winze to 150-foot level. About two feet of ore shows in these workings. At 60-ft. from shaft there is a raise to 40-foot level. Just south of the raise is a small stope. Here the vein reaches a maximum width of 8 ft.

On 100-foot level: Drift S. 60 ft.; at 25 ft. from shaft 25-foot raise. Here the ore crosses the dike.

On 150-foot level: Drift N. 60 ft.; vein faulted at 40 ft. from shaft; drift S. 60 ft. At 40 ft. there is a winze to 200-foot level. Vein shows 2½ ft. to 3 ft. in winze but is cut off by a fault 20 ft. beyond. This fault also displaces the dike.

On 200-foot level: Drift 100 ft. north. Vein is faulted at 70 ft. from the shaft. Drift S. 70 ft., at 30 ft. from shaft, stope 30 ft. long, to level above, 5 ft. wide.

On 300-foot level: Drift N. 25 ft. and S. 80 ft. At 40 feet south of shaft, crosscut to southwest 30 ft. The entire workings of this level appear to be on a fault.

The Mountain Lion shaft is 150 ft. west of the Gold Bug. This vein (which may be a faulted segment of the Gold Bug vein) strikes N. 40° W., dips 45° NE. The footwall is granite and hanging wall is a diorite dike. There is some two and one-half feet of ore showing in the bottom of this shaft.

The One Man shaft, 105 ft. deep, is 275 ft. southwest of the Gold Bug shaft.

Some high grade ore has been taken from these workings and a small shipment has recently been made to the smelter. This shipment is reported to have contained gross values of $150 per ton. The average grade of the ores is not known.

Two men are working in the Mountain Lion shaft.

Gold Crown Group. It comprises 46 acres, patented, located in Sec. 11 and 12, T. 30 S., R. 40 E., M. D. M., two and one-half miles south of Johannesburg, in the Stringer mining district. Elevation 4000 feet. Owner, Hiram E. Casey, 415 Spring Arcade Building, Los Angeles.

Idle.

Bibl: State Mineralogist's Reports XIV, p. 494; XXV, p. 35.

Golden Group (Jack Rabbit). It comprises 6 claims, 120 acres, located in Sec. 34, T. 30 S., R. 32 E., M. D. M., in Amalie mining district, 8 miles east of Caliente. Elevation 2000 feet. Owner, *New Ferris Mining Company;* Raymone E. Webber, president, Caliente, California.

The vein is 20 ft. in width, strikes northwest and dips 45° north. Formation is granite.

Development consists of shaft 200 ft. deep with three levels. Idle.

Bibl: State Mineralogist's Reports XIV, p. 495; XXV, p. 35.

Gold Hill Group (No. 21) of 7 claims is in Sec. 21 or 22, T. 28 S., R. 34 E., M. D. M., about 34 miles northeast of Caliente, in the Green Mountain district. It is in the Piute Mountains some two miles southwest of Bright Star Mine. Elevation about 7400 feet. Owners, A. R. Greenslitt, R. E. Baughman, John Holzgraffe, 1128 West 7th Street, Los Angeles and Flournoy Carter, Oxnard, California.

The rocks exposed on these claims consist of quartzite schist, gneissoid granodiorite and quartz porphyry. Three veins occur in these rocks. The Gold Hill vein is in the schist. Strike of the vein is S. 35° W., dip 70° SE. Strike of the schist is S. 15° E. This vein, lenticular in character, is from 6 inches to 4 feet wide and it is reported that it can be traced to the Bright Star Mine on the northeast side of Piute Peak. The vein filling consists of talc, quartz, crushed quartz and wall rock. Mineralization is free gold, pyrite and arsenopyrite. Values are irregularly distributed in the vein, ranging from $3 to $100 per ton in the ore-shoots.

Principal workings on this vein consist of three old shafts (inaccessible) 50, 80 and 100 ft. deep, respectively. These shafts are from 30 ft. to 50 ft. apart on the strike of the vein. About 25 ft. northeast of the 50-foot shaft is the present vertical shaft which is 46 ft. deep, with a drift of 30 ft. southwest, at the bottom. In the face of this drift the vein is 37 inches wide. Some 40 ft. below the collar of the shaft is an old tunnel now caved. About 500 ft. east of the Gold Hill is a similar vein which shows quartz up to two feet in thickness. This vein has been prospected by a series of open cuts.

Approximately 1500 ft. east of the Gold Hill there is a quartz porphyry dike some 200 ft. in width. On the hanging wall or east side of this dike, there is a quartz vein from 2 ft. to 5 ft. wide. Its strike is S. 40° W., dip 60° to 70° SE. The fissure is from 4 ft. to 7 ft. wide. Vein filling, other than quartz, is talc and decomposed wall rock. Mineralization consists of pyrite and arsenical pyrite. Developed by open cuts and a tunnel driven southwest 160 ft. Apparently values encountered in tunnel were low grade.

There is a spring flowing about 7 gallons per minute in the gulch some 500 ft. west of the last-described tunnel.

Idle except for assessment work.

Gold Pass Mine (No. 22) of five claims is in the Rademacher district, about 21 miles north of Randsburg and 6 miles north of Searles Station. It adjoins the Yellow Treasure on the east. Elevation about 3300 feet. Owner, F. Reynolds, Randsburg, California.

Here a rhyolite dike about 1000 ft. wide occurs in the granite. Its strike is approximately N. 35° W. A vein, in the granite, strike N. 45° E., dip 85° NE., cuts the dike for a distance of something over 1000 ft. This vein fills a fault fissure which is from 1 ft. to 7 ft. wide, average about 2½ ft. The vein filling consists of quartz from a few inches to 3 feet wide and crushed and altered rhyolite. The values occur free and in the iron and copper sulphides.

Development consists of 120-foot shaft and a 70-foot tunnel. The shaft is filled to within 60 ft. of its collar. In the shaft, the vein has a rhyolite hanging wall and granite footwall for the first 40 ft., after which it passes wholly into the rhyolite. At the 60-foot level a drift has been driven 85 ft. southwest. At 30 ft. from the shaft there is a stope 20 ft. long, 2½ ft. wide and 20 ft. high. Ore varies from a few inches to 3 feet wide. In the face of the drift the vein is about 7 ft. wide and is reported to be ore.

At the collar of the shaft, a tunnel has been driven 70 ft. southwest. In this tunnel the vein is wholly in the rhyolite, has well-defined walls and an average width of about two feet. The vein filling is quartz. No accurate estimate of values could be obtained.

Idle except for assessment work.

Gold Peak Mine (No. 73), consisting of 17 claims, is in Sec. 6. T. 29 S., R. 36 E., M. D. M., in the Sageland mining district, three miles west of Dove Springs and 10 miles northwest of Cantil. Elevation 5500 feet. Owner, Gold Peak Mines, Ltd., G. A. Karpe, 612 H. W. Hellman Building, Los Angeles.

The vein occurs in the granitic country rock of this region. Its strike is northwest–southeast and it has a very flat dip to the southwest (about 15° to 20°). As exposed in numerous short tunnels, it shows a width of 6 inches to 4 feet and probably averages about 18 inches.

Development consists of several tunnels the longest of which is 120 ft. The gold occurs free and in the pyrite. No accurate estimate of average values was obtainable.

A mill was erected at Dove Springs some three miles east of the mine. It consists of No. 2 Wheeling crusher; two 1250-lb. stamps; two $2\frac{1}{2}$-ft. by 5-ft. plates, run by a 15-h.p. gas engine.

Idle except for assessment work.

Goler Canyon Placers (No. 23), Goler Canyon Mining Company, Inc., 308 Spreckels Building, Los Angeles; officers, V. E. Britton, president; J. D. Murphy, vice president; Frederic W. Bakes, secretary. Capitalized for 1,500,000 shares at 25¢ a share.

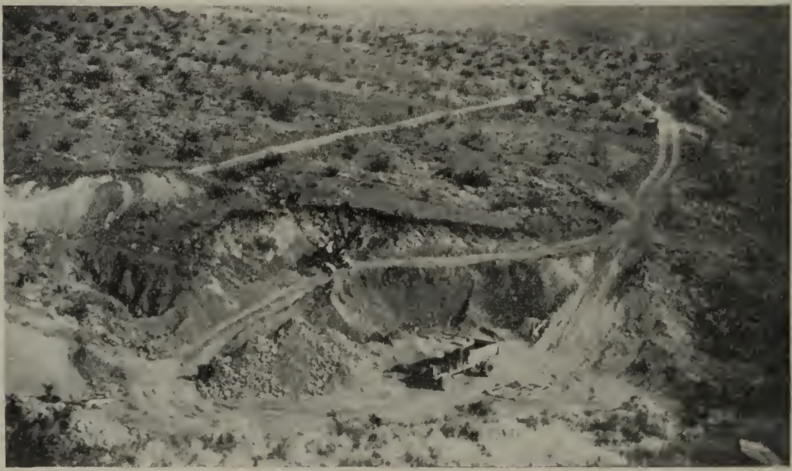

FIG. 4. Goler Canyon Placers—Goler Canyon Mining Co., Goler. (*Photo by Walter Abel.*)

Holdings comprise the following placer claims: Chief Commander, Sparkplug, Sparkplug No. 2, Golden Vault, Gold Zone, Chief Assistant, Golden Gulch No. 1 to 3, Katydid No. 1 to 11. Approximately 1500 acres situated in Sec. 1, 2 and 11, T. 29 S., R. 39 E., in Goler mining district, 9 miles northwest of Randsburg. Engineer's report by Walter Abel, Los Angeles.

Proved area about 1000 ft. in length by 200 ft. wide and 7 ft. in depth. 1,400,000 cubic yards, average value of 80 cents per cubic yard. Probable yardage estimated as 10,000,000 to 15,000,000 cubic yards, with average value of 68 cents per cubic yard. Thirty thousand dollars spent on pilot

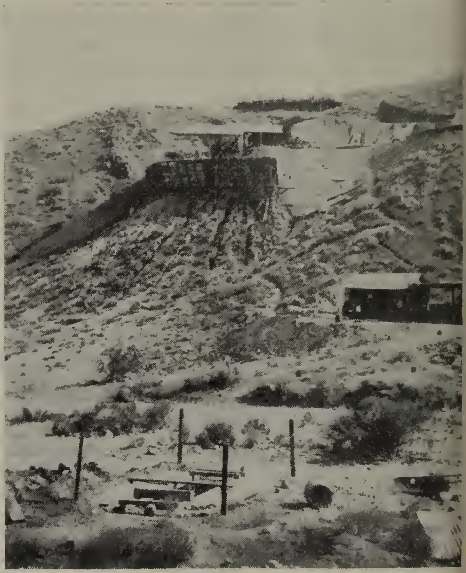

FIG. 5. Pilot washing and sluicing plant. Goler Canyon Placers, Goler. (*Photo by Walter Abel.*)

plant and prospecting the ground with test pits and shafts. In testing operations have recovered $1,500 in nuggets, values ranging from 50 cents to $400 in individual nuggets.

Company plans to install washing plant with capacity of 2000 cubic yards per day. Estimated water required is 200 gallons per cubic yard, requiring 480,000 gallons daily. The company also plans to sink its own wells for water supply.

Granite King Mine (No. 75). It comprises four claims situated in Sec. 28, T. 29 S., R. 36 E., M. D. M., 32 miles northeast of Mojave. Elevation 4500 feet. Owner, Charles Burch, Mojave, California.

Vein of quartz four feet in width occurs in granite; strike north-south, dip vertical.

Equipment consists of two-stamp mill located in a wash one mile east of property.

Idle.

Greenhorn Caves Placer Mines. It comprises 8 claims situated in Greenhorn Gulch, on east slope of Greenhorn Mountain, in T. 27 S., R. 32 E., M. D. M., 13 miles southwest of Isabella. Elevation 4000 feet. Owners, Chas. B. Tibbetts, R. L. Tibbetts, E. F. Brittan and Monroe George, Bakersfield, California. Under lease to Greenhorn Caves Mining Company, H. P. Bardshaw, president and manager, Los Angeles.

Development consists of tunnel 100 ft. in length 150 ft. in elevation below mouth of caves.

It is reported that $60,000 has been recovered in placer gold from these caves. Five men are employed on development work.

Gwynne and Jennette (Jeannette?) Mines (Mace) (No. 25.) The property comprises the following claims: Chief, Jennette, Jennette Annex, Hard Luck, Shasta, Mace Ranch and Dead Tree, a total of 445 acres (patented) situated in Green Mountain mining district, in Secs. 21 and 22, T. 29 S., R. 34 E., M. B. M., 25 miles northeast of Caliente and three miles northeast of Piute. Elevation 7500 to 8000 feet. Owners, Otto and Jack Geringer, Chicago, Illinois.

Three roughly parallel veins occur in granite known as the Jennette, Gwynne and Kersey veins. The Gwynne and Jennette veins strike east and west and dip 40° S. Width of veins vary from 12 inches to 2 feet. The Kersey vein strikes N. 35° E. and dips 40° S. The vein quartz shows free gold associated with pyrite and marcasite, usually free-milling, high grade ore. Average value of ore milled runs $40 per ton.

Development: The Gwynne vein is developed by a shaft 300 ft. deep sunk on the vein and by two tunnels driven east on the vein. The upper tunnel is 900 ft. in length. One hundred ft. in elevation below this tunnel is the main working tunnel which has been driven east on the vein a distance of 1750 ft. At 1600 ft. a raise is being driven to the surface on the vein.

The Kersey vein which is to the southeast of the Gwynne vein is developed by a tunnel driven north 600 ft., also a winze 85 ft. deep and drift north from winze on the vein about 200 ft. Ore-shoot developed on this vein was 150 ft. in length with average width of 2 ft.

The Jennette vein is developed by a crosscut tunnel driven south 150 ft. to the vein, with drift on the vein 700 ft. west. Two ore-shoots

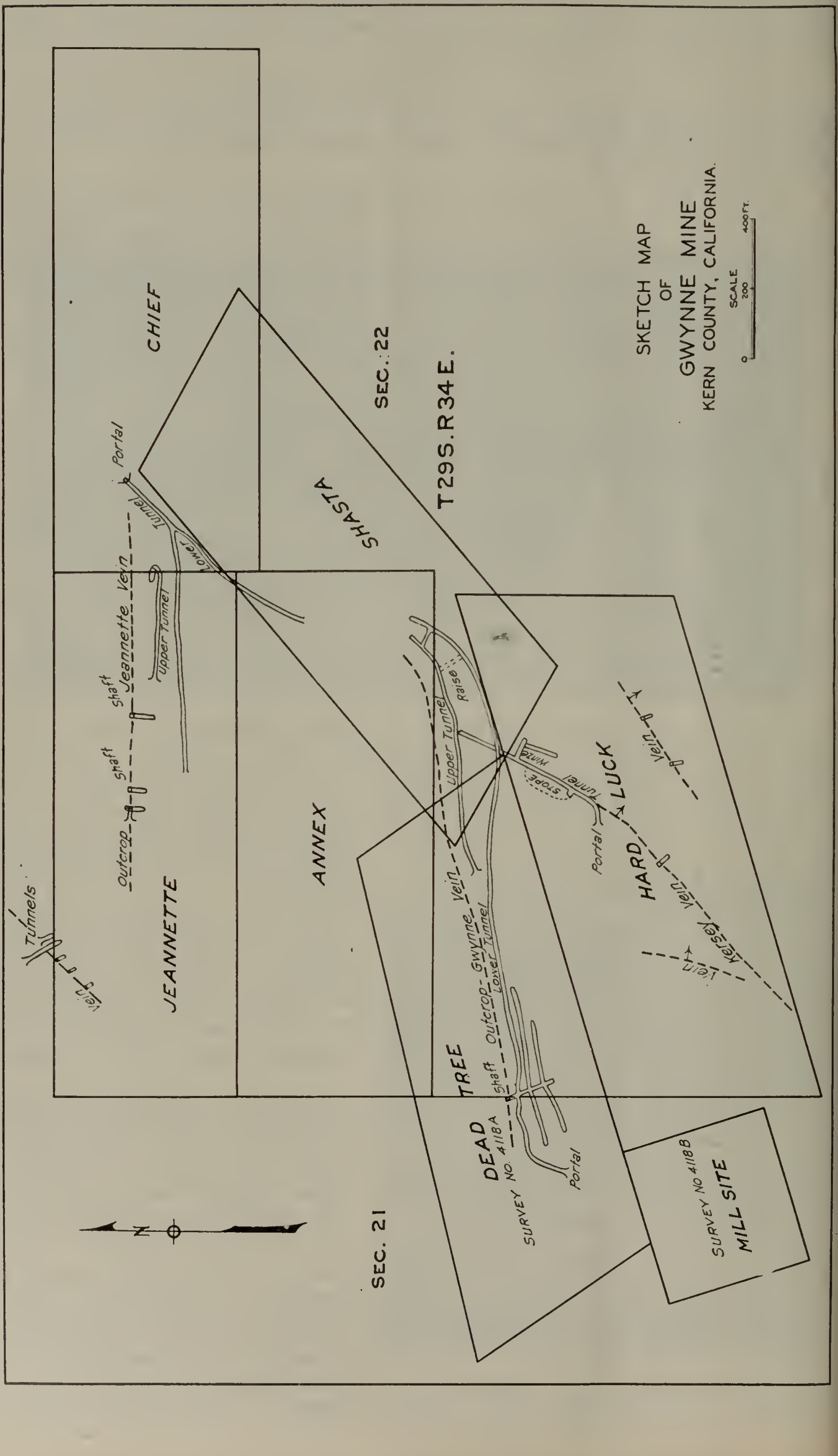
SKETCH MAP
OF
GWYNNE MINE
KERN COUNTY, CALIFORNIA.
SCALE
0
200
400 FT.
T29S. R34E.
SEC. 22
SEC. 21
N
CHIEF
JEANNETTE
ANNEX
SHASTA
HARD LUCK
DEAD TREE
SURVEY NO. 4118A
MILL SITE
SURVEY NO 4118B
Portal
Tunnel
Lower
Upper Tunnel
Jeannette Vein
shaft
shaft
Outcrop
Tunnels
Vein
Raise
Upper Tunnel
Winze
Stope
Tunnel
Portal
Vein
Vein
Kersey Vein
Vein
Outcrop - Gwynne - Vein
Lower Tunnel
shaft
Portal

Fig. 6

were developed in these workings, 300 ft. in length. The vein has an average width of 6 inches, free-milling, high grade ore. They are reported to have recovered $55 per ton.

The main crosscut tunnel has been driven south a distance of 500 ft. to intersect the Gwynne and Kersey. About 200 ft. remain to be driven to cut Gwynne vein. One hundred feet in elevation above this tunnel is upper tunnel driven west 400 ft. on vein and stoped to surface.

All mining at present is confined to the Gwynne vein, and ore recovered is reported to have an average value of $40 per ton. Ore is trammed from lower tunnel to mill having a capacity of 25 tons. Ore from 25-ton storage bin is fed to Blake type of crusher, then Hendy 4-ft. by 4-ft. ball mill. Product from ball mill is elevated by bucket elevator to Cottrell vibrating screen and screened to minus 30-mesh. Oversize is returned to ball mill and minus 30-mesh to Senn amalgamator; pulp from amalgamator to Wilfley concentrator. Concentrates recovered carry $200 per ton in gold. Tailings assay $1.50 per ton. Property has a total production of $500,000.

Six men are employed.

Bibl: State Mineralogist's Reports XII, p. 146; XIII, p. 192; XIV, pp. 498–499; XXV, pp. 36–37.

Hanover Mine (No. 76). It comprises two claims and two fractions situated in the Green Mountain mining district, in Sec. 21, T. 29 S., R. 34 E., adjoining the Gwynne Mine on the north, two miles north of Piute. Elevation 7500 feet. Owner, J. J. Wellbaun, Caliente, California.

The vein strikes N. 70° E., dips 45° SE.; average width 12 inches. The formation is granite.

Development consists of two tunnels. Upper tunnel is driven on vein 150 ft. and lower tunnel 140 ft. in elevation below upper tunnel is a crosscut tunnel driven south 300 ft. to the vein, with drifts on the vein 500 ft. northeast and 100 ft. southwest. Average value of ore stated to be $40 per ton.

Two men employed.

Helen Galvin Group (No. 87) of two placer claims are on the Kern River just above Democrat Hot Springs, some 22 miles northeast of Bakersfield. Owners, Wm. Nestell, Fred and Helene Burns, 4628 Forman Avenue, North Hollywood, California.

On these claims river gravels are somewhat irregularly distributed on benches and in the canyons on each side of the river. Pannings from some eight shallow holes in the benches and canyons all showed fair values in fine gold.

At time of visit the owner hoped to equip the property for sluicing on a moderate scale.

Huntington Mine (No. 26), comprising three claims, is in the Rademacher district about 7 miles northwest of Searles, a station on the Owens Valley branch of the Southern Pacific Railroad. Owner, Harry F. Willey, Inyokern, California.

This is an old property. The development work was probably done in the early part of this century. The country is granite which is traversed by a series of dioritic dikes. The vein, strike N. 50° E., dip 65°

SE., crosses a dike and the ore forms in the vicinity of this intersection. The shoots are short and lenticular in shape. Widths vary from a few inches to four feet.

Development consists of a tunnel on the vein 200 ft. long; two winzes each 20 ft. deep and a shaft at the face of the tunnel which is reported to be 100 ft. deep. There is also a shaft at the portal of the tunnel which is in excess of 100 ft. in depth. It is reported that the vein is stronger in the last 30 ft. of this shaft than it is nearer the surface. Good values are reported to occur in the lenticular shoots.

Idle except for assessment work.

Indian Wells Valley Group of 7 claims is in the Rademacher district on the south side of Indian Wells Valley, 6 miles north of Searles, a station on the Owens Valley branch of the Southern Pacific Railroad. Owners, O. S. Ceaser, 2600 Board of Trade Building, Chicago, and George and C. E. Albertson, Inyokern, California.

The country rock is diorite which is traversed by a series of rhyolite dikes, strike N. 35° W. A vein in the diorite, which also crosses the dikes, strikes N. 80° E., dips 55° S. Its width varies from 12 inches to 3½ feet. The vein filling is quartz. Mineralization consists of the oxides of iron and manganese, pyrite, chalcopyrite and free gold.

Development consists of 500-foot crosscut tunnel driven south from the base of the hill. This crosscut, which is in diorite, did not reach the vein. Above on the hill a shaft hs been sunk on the vein 35 ft. deep.

Three men are employed building an arrastre.

International Mining and Milling Company, A. G. Ilseng, president, 183 North Martel Street, Los Angeles, has taken over the King Solomon, the K. C. N. Group, G. B., Boston Fraction and Windy mines at Randsburg and Johannesburg.

To date their operations have been confined to the King Solomon and Windy mines, although it is planned to immediately start some work on the G. B.

Under the names of the two mines above mentioned will be found descriptions of these operations.

At present the company is employing 55 men.

Joe Walker Mine (No. 27). It comprises two patented claims known as Lena and Hidden Queen, situated in Secs. 7 and 12, T. 29 S., R. 33 E., M. D. M., in low foothills at the northeastern edge of Walkers Basin, 7 miles northwest of Piute. Owner, J. B. Haggin and Phoebe A. Hearst estate, c/o Edwin Clark, New York City. The mine was discovered in 1865 and operated until 1874.

The vein of quartz occurs in granite, strike NE. and SW., dip 60° SE. The width of the vein was from 2 ft. to 20 ft. and the average width stoped was 4 ft. The ore was treated in a 20-stamp mill and is reported to have averaged $24 per ton in gold. The vein quartz contained 3% of pyrite and arsenopyrite.

Development consisted of two incline shafts about 400 ft. apart, sunk on the vein to depths of 250 ft. and 350 ft. Ore stoped out from 250 and 300-foot levels to surface for a distance of 700 ft. The mine yielded from $500,000 to $600,000.

Idle.

Bibl: State Mineralogist's Report VIII, pp. 317–318.

Karma Mine (No. 79). It comprises the following claims: Karma, Ajax, Intention Junction, totaling 70 acres, located in Sec. 6, T. 10 N., R. 12 W., S. B. M., about four miles south of Mojave. Elevation 3200 feet. Owner, E. L. Wegmann, Mojave, California.

Two parallel veins have been developed on the property. The outcrops of these veins can be traced on the surface for 1000 ft. The veins vary in width from 4 ft. to 15 ft. The general course of the veins is N. 10° W., dip 60° east, with salicified rhyolite-porphyry walls.

Development consists of a tunnel driven south 1800 ft. on the Karma vein. About 100 ft. in elevation above the portal of the tunnel, there is a glory hole stope 200 ft. in length and about 50 ft. in width. On the same level as the tunnel, a shaft has been sunk to a depth of 160 ft. The pay shoot developed in the tunnel is said to be 240 ft. in length and it has a width of 15 ft. A high grade streak of ore occurs on the hanging wall of the vein.

Mine equipment consists of cars, assay office, shops and dwellings. Reduction equipment consists of 20 stamps, weight 850 pounds each.

Bibl: State Mineralogist's Reports XIV, p. 444; XIX, p. 161; XXV, p. 37.

Kelso Creek Placers (No. 29) are situated on Kelso Creek in Sec. 16, T. 28 S., R. 35 E., M. D. M., 16 miles south of Weldon. Elevation 4500 feet. Owner, Andrew Miller, Sageland, California. Under lease to John F. Ruether and R. F. Bailey, Alhambra, California.

Gravel consists of unconsolidated wash in Kelso Creek, made up of sand and gravel wash with large granite boulders. The creek at this point is 150 ft. in width with from 10 ft to 30 ft. to bedrock. Bedrock is granite. The gold is fine with occasional coarse pieces. Average value obtained from test pits is reported to be 50 cents per cubic yard. The source of the gold is from erosion of quartz veins and stringers as Kelso Creek passes through a mineralized district in the Piute Mountains.

Equipment: The gravel from creek is delivered to plant by dragline which is operated by 40-h.p. gas engine hoist. The gravel passes over grizzly and is screened to 2-inch size. The oversize goes from grizzly to waste dump. The minus 2-inch size material goes to hopper, then to revolving screen 5 ft. long by 4 ft. in diameter. Revolving screen is driven by 10-h.p. motor. The gravel is screened to $\frac{1}{4}$-inch which passes over McClellan Electro malgamator, then to sluices. The plant operated a short time only due to shortage of water, mechanical difficulties and faulty design.

Idle.

Keyes Mine (No. 30). It comprises 13 claims totaling 260 acres, situated in Sec. 26, T. 26 S., R. 32 E., M. D. M., in Keyes mining district, three miles southeast of Isabella. Elevation 3600 feet. Owner, *Kern River Mining Company,* A. A. Cash, secretary. Office address: 2240 San Fernando Road, Los Angeles. It was under lease and bond to the *Minaret Mines Company,* Charles C. Randall, president; J. E. Fisher, secretary, Anaheim, California, from 1928 to 1932.

During this period the company sunk a winze 100 ft. deep on the vein at a point 1200 ft. southwest of crosscut tunnel. On the 100-foot level of winze 700 ft. of drifting was done on the vein. Three winzes were sunk from the 100-foot level to a depth of 50 ft. The ore-shoot developed was 200 ft. in length. Width of vein varied from 10 to 18 inches, with an average value of $40 per ton. From 52 tons of ore mined from 100-foot level, a recovery of $39.50 per ton was made in mill.

The property was taken over by the *Thornton Engineering Company,* of Los Angeles, Edward Thornton, president, Subway Terminal Building, Los Angeles, in the early part of 1932. This company operated the property until the latter part of 1932 when it suspended operations. They retimbered the 900 ft. of drift on the vein from the main crosscut tunnel.

Five parallel veins occur in the granite. The principal production has been from the Keyes, Matilda and Garneshee veins. The Keyes vein is from 12 inches to 2 feet wide, strike N. 45° E., dip 70° SE. The vein quartz is free-milling and high grade. The principal development is confined to the Keyes vein and consists of a crosscut tunnel driven west 840 ft. to the vein, with a drift southwest on the vein 1400 ft. At 800 ft. southwest of crosscut tunnel a winze is sunk to a depth of 100 ft. At 1200 ft. southwest of crosscut tunnel is the Randall winze 100 ft. deep, with 700 ft. of development work on 100-ft. level. The main crosscut tunnel cut the Matilda vein at 590 ft. from portal of tunnel. The depth of the workings below the surface outcrop of Keyes vein is 450 ft. and they have been stoped from the tunnel level to the surface.

Mine equipment consists of a Chicago pneumatic compressor, capacity 300 cu. ft. per minute; Ingersoll-Rand compressor Imperial type No. 10 (22-in. by 60-in.) (13-in. by 16-in.) driven by 250-h.p. motor.

Mill equipment: Ten 1000-lb. stamps; amalgamation plates; one Wilfley concentrator; one Cottrell concentrator. Mill driven by 50-h.p. General Electric motor. Idle.

Total production of property $450,000.

Bibl: State Mineralogist's Reports XXV, pp. 37–38; XIV, p. 499; XIII, p. 191; XII, p. 145. U. S. Geol. Survey, Mineral Resources of United States.

King Solomon Mine (No. 31). It comprises two claims situated in Secs. 9 and 10, T. 28 S., R. 33 E., M. D. M., in Clear Creek mining district, 4 miles east of Havilah. Owner, J. L. Stubblefield, E. A. Rosa and J. C. Walsher, of Havilah and Bakersfield. The property was one of the important producers of the Clear Creek district until 1912.

Workings are now caved and present work is confined to the northeast end of the property. The main tunnel level of the King Solomon was driven 2800 ft. northeast on the vein in granite connecting with a shaft 300 ft. deep. It is reported that vein was stoped to surface from this tunnel level. Vein 2 ft. to 4 ft. in width. Strike is NE. and SW., dip 80° NW. Vein quartz is mineralized with free gold, pyrite and arsenopyrite. There is a 5-stamp mill on the property. There are 20,000 tons of tailings below mill reported to carry $2 per ton in gold. Present work consists of a number of shafts sunk on narrow stringer veins in granite to the north of the King Solomon workings. These shafts are 50 ft. to 72 ft. deep and 100 sacks of ore has been extracted reported to carry $100 per ton in gold.

Three men employed.

Bibl: State Mineralogist's Report XIV, p. 500.

King Solomon Mine (No. 59), comprising 5 patented claims, is in Sec. 35, T. 29 S., R. 40 E., M. D. M., three-quarters of a mile west of Johannesburg in the Rand district. Elevation 3900 feet. Owner, King Solomon Consolidated Mines Company, Los Angeles; E. Shipsey, president; under lease and bond to *International Mining and Milling Compay,* A. G. Ilseng, president, 183 North Martel Street, Los Angeles.

Several veins have been more or less explored on this property. The wall rocks are in places schist and in other places quartz monzonite. Sometimes one wall is schist and the other quartz monzonite. Generally the walls are well defined, distinctly showing slickensides and lined with gouge. The vein filling consists largely of brecciated and iron-stained schist with some vein quartz.

There are four principal veins known as the Blind, Nosser, Magpie and King Solomon. These vary in strike from N. 35° W. to N. 80° E., while the dips range from 40° to 50° to the northeast. They are generally narrow, the actual pay ore averaging now about one foot. What is presumed to be the Magpie vein, where it was encountered by a crosscut on the 550-ft. level, shows a brecciated zone about 30 ft. wide with 9 ft. of solid quartz on the hanging wall side. This quartz it not ore.

The property has been developed by a number of shallow shafts and the main two-compartment shaft, which has been sunk to about 580 feet on approximately a 45° incline. There are 7 levels and about 11,000 ft. of drifts and crosscuts. The lowest level is the 550.

The present company has done the following development work since taking possession of the property in September, 1932:

On the 300-ft. level, crosscut from the Magpie vein in a westerly direction 160 ft. toward the Hector vein. There is yet some 50 ft. to go before intersecting this vein. A crosscut has been driven north 90 ft. to the King Solomon vein. Drifting on this vein 100 ft. southeast and 212 ft. northwest. The vein showed only a few inches wide with low values. Still driving northwest to get under old workings.

On the 350-ft. level a drift has been driven southeast on the Nosser vein 100 ft. This has been stoped to a height of 25 ft. and is still being worked.

On the 450-ft. level they have drifted 250 ft. southeast on the Nosser vein. This is all in ore averaging about 12 inches wide and reported to average $25 per ton. This has been stoped to a height of about 30 ft.

On the 550-ft. level a crosscut has been driven west 627 ft. This crosscut has exposed three veins. At 150 ft. from the shaft the Blind vein was encountered and a drift driven northwest 65 ft. and is still driving. It shows an average width of 6 inches, carrying good values.

At 250 ft. from the shaft the Nosser vein was found. A drift was driven northwest 125 ft. and southeast 215 ft. Driving to the southeast is still in progress. The vein is strong, averaging about 18 inches, carrying considerable sulphides. Two very short shoots were encountered in the northwest drift.

At 600 ft. from the shaft the Magpie (?) vein was intersected. It showed 9 ft. of quartz on the hanging wall and a brecciated zone some 27 ft. wide. A drift has been driven northwest 60 ft. and is now being continued. At the face it is about three ft. wide. There is very little value in this portion of the vein.

In addition to the development work the company has installed a new head frame and is adding to its milling equipment. When complete the mill will consist of the following: 6 by 10 Dodge crusher; 14-in. belt feeder to 14-in. cross conveyor for distribution to the bins; three bins, each about 50 tons capacity. Challenge feeders to 15 stamps followed by plates, 2-in. centrifugal pump to 22-ft. Dorr thickener. Thickened pulp to 4 by 6-ft. Traylor ball mill in closed circuit with duplex Dorr classifier. Overflow from classifier to conditioner and four Grotch flotation cells. Tailings to 2-in. centrifugal pump and 24-ft. Dorr thickener for dewatering. The plant is operated by electrical power. Each machine is motor-driven. Capacity 45 to 50 tons per day. Mine is equipped with motor-driven compressor and electric hoist. Ore is hoisted in a one-ton skip.

In the first year of operation they have milled about 3300 tons from which there has been recovered more than $20 per ton. About 40 men are employed.

Bibl: State Mineralogist's Reports XIV, p. 500; XXV, p. 38. Bull. 95, Geology and Ore Deposits of the Randsburg Quadrangle, pp. 136–137.

Laurel Group of Mines. It comprises 6 claims, known as Marble, Marble No. 1 and No. 2, Perth Amboy No. 1 and No. 2, situated in Sec 26, T. 27 S., R. 33 E., M. D. M., on ridge west of Erskine Creek, in Valley View mining district, 14 miles southeast of Isabella. Elevation 5000 feet. Owner, John Hooper, Hobo Hot Springs, California. Under lease and bond to *Laurel Development Company,* of Los Angeles.

The formation is granitoid and schistose rocks with interbedded limestone near contact of quartz-monzonite. Ore occurs in metamorphic limestone. The orebody is 6 ft. to 12 ft. wide and occurs along a fracture in the limestone which strikes N. 30° W. and dips 70° E.

Development consists of lower tunnel driven west 180 ft. to mineralized fracture, with drift southwest 175 ft. At 75 ft. northwest of crosscut, there is a raise in ore for a distance of 50 ft. About 80 ft. in elevation above this tunnel a tunnel has been driven 100 ft. northwest along mineralized fracture. There is a shaft 42 ft. deep sunk on the fracture 12 ft. in elevation below upper tunnel.

Ore carries gold and silver values. The vein quartz is mineralized with pyrite, chalcopyrite and sphalerite. Ore averages $7 per ton in gold, 4 ounces in silver per ton, with 2% copper.

Equipment consists of 50-ton ore bin at mouth of lower tunnel. Aerial tram 1200 ft. in length to loading bin with a capacity of 50 tons (6-in. by 10-in.) (10-in. by 10-in.); Ingersoll-Rand compressor driven by 40-h.p. gas engine; 5-stamp mill at Hobo Hot Springs.

Six men employed.

Lehigh Valley Group of two claims is situated some three miles north of Rademacher and about 7 miles northwest of Searle Station, on the south side of Indian Wells Valley. Owners, P. R. and B. J. Light, C. F. Walker and Maxwell Orr, Inyokern, California.

This property is in a low range of hills at the northeast end of the El Paso range of mountains, in the Rademacher district. The vein occurs in the granite, strike N. 70° E., dip 60° N. It has well-defined walls, which are about 6 ft. apart. The ore forms by replacement of the crushed country rock between the walls. It usually consists of about 6 inches of quartz on the hanging wall and from 12 to 18 inches on the foot, with less altered granite between. Ore forms small, lenticular masses. Mineralization consists of free gold and pyrite. Fifty feet north is a parallel vein which accompanies a felsitic dike. This vein, as exposed in a 45-foot shaft, varies from a few inches to two feet thick. This shaft, together with a 30-ft. shaft on the other vein and a 25-ft. drift at the 20-ft. level, constitute development work to date. Reported values range from $15 to $25 per ton.

Three men are employed building an arrastre.

Little Butte Mine (No. 32). It comprises 80 acres in the Rand district, in Sec. 35, T. 29 S., R. 40 E., M. D. M., about one mile west of Johannesburg. Elevation 3000 feet. Owner, Little Butte Mining and Milling Company, Los Angeles; C. W. Clark, president; Dr. J. W. Oakley, secretary, 612 Security Building, Los Angeles.

Two parallel veins occur in the schist and strike northwest with a dip of 45° NE. These veins cut through rhyolite dikes. The ore mined from these veins is reported to be high grade and said to carry values from $25 to $600 per ton.

Development consists of a shaft sunk on an incline to a depth of 600 ft., with 9 levels. Total amount of drifting and crosscutting amounts to several thousand feet. Sulphide ore is reported to have been encountered on the 600-ft. level. It is said to carry values in gold and silver. The production of the property is estimated to have been $400,000. The mine is equipped with electric hoist and 2-stamp mill, consisting of 950-pound stamps. Idle.

Bibl: State Mineralogist's Reports XIV, p. 502; XXV, p. 39. Bull. 95, p. 137.

Little Charlie Group of Mines. It comprises two claims located on the west slope of El Paso range of mountains, two miles northwest of Gypsite, a station on the Southern Pacific Railroad. Owner, Mrs. J. S. Bishop, Saltdale, California.

The vein occurs in schist, strike northwest-southeast, dip 70° W.; width 6 to 12 inches. The vein quartz is iron-stained and reported to carry $20 per ton in gold.

Development consists of tunnel driven northwest on the vein 200 feet. Two ore-shoots have been developed in these workings and ore is being sacked and hauled to Cantil to be milled.

Three men are employed.

Little Joe Mine (No. 80). It comprises two claims situated in Sec. 29, T. 28 S., R. 34 E., M. D. M., in Green Mountain mining district, six miles north of Piute. Elevation 6800 feet. Owner, Henry Redman, Piute.

Two parallel quartz veins occur in granite; strike N. 70° E., dip 68° S.; width 6 to 18 inches.

Development consists of several tunnels and shallow shafts. Lower tunnel driven as crosscut 40 ft. north, then drift on vein 350 ft. to northeast. At 200 ft. northeast of portal connects with shafts from surface 76 ft. deep. At 200 ft. west of these workings several shafts 40 ft. to 50 ft. in depth have been sunk on a parallel vein. Ore extracted from different workings is reported to have an average value of $25 per ton.

Equipment consists of two 1000-lb. stamps; 6-in. by 8-in. Blake crusher; 15-h.p. steam boiler; 10-h.p. Atlas steam engine drives mill.

Two men are employed.

Long Tom Mine (No. 33), consisting of 7 patented claims, totaling 129.6 acres, is situated in the Long Tom mining district, in Sec. 21, T. 27 S., R. 29 E., M. D. M., 20 miles northeast of Bakersfield. The claims are Hirshfield, Webb, Bell, Lady Langtry, Antrim, Josephine and Golden Curry. This property is two miles north of Poso Creek. Owner, Long Tom Mining and Milling Company, Frank Hand, president, 825 Yale Street, Fresno, California.

The principal workings were on the southeasterly portion of the property. This vein (known as the Long Tom vein) has an average width of 16 inches, strike northwest-southeast, dip 45° N. The footwall of the vein is diabase with a granite hanging wall.

The development work consisted of a shaft on the vein, variously reported to be from 380 ft. to 500 ft. deep, with several thousand feet of drifts. The vein has been stoped from the 300-ft. level to surface, for a length of 150 ft. These workings are now inaccessible.

For the past year this property has been under lease to F. B. Webb, who lives on the property. He has confined his work to Tuckers Gulch, which is just northeast of the Long Tom workings.

Considerable tunneling and gophering was done here in the early days on two intersecting veins in the granite, the Antrim and the Tucker. These veins strike NE.-SW. The Tucker dips 40° SE., the Antrim about 20° NW. Present workings are on a vein which parallels the Antrim just below its intersection with the Tucker. Its average width is about five inches. It is reported that 116 tons of this ore yielded $2,800 in the mill. They are now sinking a shaft on the northwest side of the gulch in an attempt to pick up the Antrim vein below the old workings.

In addition to an old 20-stamp mill, there is a plant now in use which consists of the following:

Two 20-ton bins; 5-in. by 7-in. Universal crusher; Challenge feeder; 5-ft. Huntington mill; 4-ft. by 8-ft. plates and a riffle box.

Plant is run by 15-h.p. gas engine. Water is obtained from springs through 3200 ft. of 1½-in. pipe.

Four men working.

Long Tom tailings have been treated by Hartley Phillips, Fresno, California.

Dumps from arrastras and old mills were hauled to a plant in Tuckers Gulch. The plant consists of two 20-ton tanks, circulating pump and zinc boxes. It has been operating for about three years. Reported to have recovered about $5 per ton.

Bibl: State Mineralogist's Reports XXV, p. 39; XIV, p. 502; XI, p. 238.

Lost Keys Mine (No. 34), comprising 10 claims, is in the Rademacher district about 6 miles northwest of Searles Station on the Owens Valley branch of the Southern Pacific Railroad. Elevation approximately 3500 feet. Owners, David J. O'Connor and Matt L. Ruppert, Inyokern, California, and Walter A. Grosse, 2073 West Jefferson Street, Los Angeles.

The granite country rock of these claims is traversed by a series of basaltic to dioritic dikes. The vein, strike N. 60° W., dip 80° NE., occurs between granitic walls. It is opened by a shaft 105 ft. deep. Some 50 ft. west of the shaft is a diorite dike about 50 ft. wide, strike north-south, while a few feet north of the shaft is a basaltic dike with a northeast strike. The vein as exposed in the shaft is wholly within the granite but is approaching the basaltic dike on its dip and, no doubt, crosses the diorite dike to the west. Between walls the vein is about three feet wide but the quartz varies from a few inches to the full width of the vein, averaging about two feet. Mineralization consists of free gold and pyrite in the hard quartz which is also stained by the oxides of iron and manganese. There has been taken from this shaft some 40 tons of ore which is reported to average about $20 per ton.

Equipment consists of portable compressor and hoist.

Three men are employed sinking the shaft.

Maltby Mine (Placer) is on the Maltby Ranch, about four miles northwest of Woody. Owner ——— Maltby, of Woody, California. Leased to Vern M. Osborn, 722 Aliso Street, Los Angeles, and O. O. Cashmere, 1438 Sixth Street, Santa Monica, California.

Here, in a shallow valley, between gently sloping hills, an old river channel has been prospected for a length of 1300 ft. It is from 150 ft. to 350 ft. wide. The gravel is from 4 ft. to 6 ft. thick, with soil overburden of from 2 ft. to 6 ft., and a granite bedrock. Average values are estimated at $1.75 per yard.

Water is obtained from Grizzly Gulch at the lower end of the proved channel and the sluicing plant has been built on the top of the precipitous bank of this gulch.

Material is loaded into five-ton trucks by a Marion caterpillar shovel, having a ¾-cu. yd. dipper. Capacity of the plant is 40 yards per hour.

Six men are working.

Mammoth Mine (No. 35). It comprises 12 claims, totaling 240 acres, situated in the Keyes mining district, in Sec. 35, T. 26 S., R. 32

E., M. D. M., five miles south of Isabella. Elevation 3850 feet. Owner, *Mammoth Mountain Mining Company;* J. H. Copelin, president; G. W. Russell, secretary. Offices, Chamber of Commerce Building, Los Angeles.

The property was discovered in 1855, shortly after the discovery of the Keyes Mine and has been operated off and on for the past sixty years. The property is reported to have a production record of $500,000. The Mammoth vein is from 2 ft. to 15 ft. wide, average width being 3 ft. The vein strikes northeast and southwest, dips 70° east, with 10,000 ft. on the lode. The formation is granite, although on the footwall the casing is made up of slate. The vein quartz is free-milling, said to carry $5 to $25 per ton in gold. Two veins have been developed on the lower tunnel known as Footwall and Hanging Wall veins. The lower or main working tunnel is driven S. 40° W., 1980 ft. At 800 ft. from the portal, a winze has been sunk on the Footwall vein to a depth of 200 ft. At 165 ft. below the collar of the winze, a level has been driven on the vein 100 ft. to the northeast and 180 ft. to the southwest. Near the location of the winze a raise has been put up 95 ft. to No. 4 tunnel.

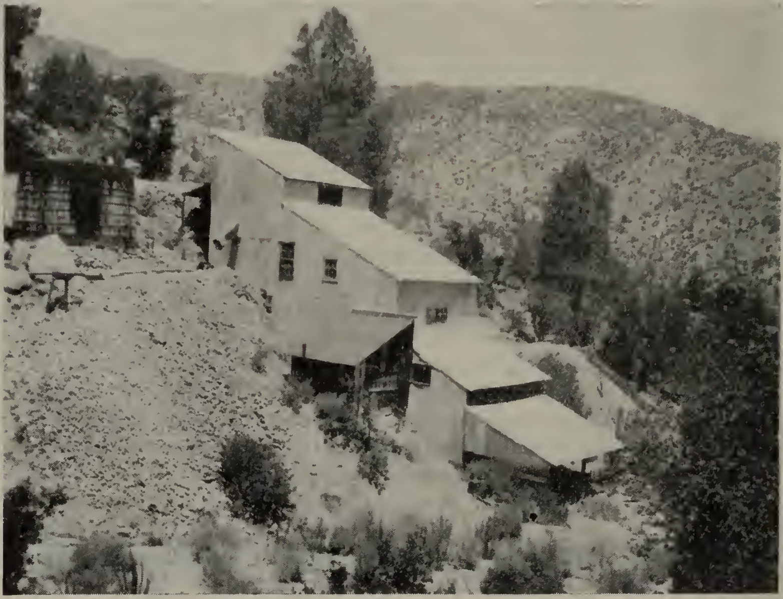

FIG. 7. Ten-stamp mill at Mammoth Mine, Keyes Mining District.

Since Report XXV of the State Mineralogist the following development work on the property has been accomplished: No. 6 lower tunnel has been advanced a total distance of 1980 ft. In the face of this tunnel there is a vein of quartz three feet in width. About 600 ft. south of winze, there is a raise 122 ft. above tunnel in the footwall of the vein. At 450 ft. south of this raise, a raise has been put up 117 ft., intersecting the Sumner tunnel level (No. 3 tunnel). At 150 ft. south of this raise, a winze is sunk on the vein 50 ft. Width of vein encountered in winze shows three feet of quartz.

Workings on the vein are as follows:

No. 6, Lower Tunnel	1980 ft.
No. 4 Tunnel 104 feet in elevation above No. 5	775 ft.
No. 3 Tunnel 119 feet in elevation above No. 5	735 ft.
No. 2 Tunnel 145 feet in elevation above No. 4	450 ft.
Total	3940 ft.

On No. 2 tunnel, which is located on the southwest slope of the hill, the McGill ore-shoot is stated to have been 280 ft. long, with an average width of 4 ft. This shoot was stoped to the surface a distance of 150 ft. The ore mined is said to have carried values in gold running from $20 to $54 per ton.

Tunnel No. 3 developed the Tom Lane ore-shoot, which is stated to have been 160 ft. long, by 120 ft. high and with an average width of 4 ft.

Tunnel No. 4 developed the Higgins ore-shoot, which was 500 ft. long and 150 ft. high, average width being 4 ft.

In the winze on tunnel No. 5 an ore-shoot 120 ft. long by 3 ft. wide has been developed. The ore mined from the winze is reported to have plated $17 per ton. The production from this shoot of ore was $20,000.

Mine equipment consists of single-drum, 10-h.p. electric-driven hoist; Deming triplex pump driven by 3-h.p. motor; 12-in. by 12-in. compressor driven by 50-h.p. motor; blacksmith shop and dwellings.

Mill equipment consists of 10-stamp mill; 1000-pound stamps; amalgamation plates. The mill is electrically driven. Electric power is secured from the Southern California Edison Company.

Three men are employed on development work.

Bibl: State Mineralogist's Reports XIV, p. 502; XIII, p. 193; XXV, pp. 40–41.

Minnehaha Mine (No. 36). It comprises four claims, situated in Sec. 2 and 3, T. 30 S., R. 40 E., M. D. M., three miles west of Randsburg. Elevation 3800 feet. Owner, Judge E. B. Maginnis, Randsburg, California.

The vein occurs in the schist with some quartz monzonite and also cuts a rhyolite dike. The vein strikes N. 35° W. and dips 45° NE. The vein is from 2 ft. to 7 ft. in width. The values in the vein are very erratic but the ore mined is high grade, showing values of $100 per ton.

Workings consist of four tunnels, each over 400 ft. long, and four shafts about 100 ft. deep. There are over 1000 ft. of underground workings on the property, with the deepest development being about 300 ft. The property has been operated for years by leasers. It is estimated that the property has produced $100,000.

Eight men leasing, milling their ore at the Windy mill.

Bibl: State Mineralogist's Reports XIV, p. 503; XXV, pp. 41–42. Bull. 95, 'Geology and Ore Deposits of the Randsburg Quadrangle.'

Norden Placer Mine (No. 37), comprising 9 placer claims, something over 120 acres, is located in Sec. 22, T. 29 S., R. 40 E., M. D. M., two miles north of Randsburg. Elevation 2500 feet. Controlled by *Yellow Channel Mining Company,* Gordon Cole, 616 North Manhattan Place, Los Angeles.

The auriferous gravels occur in the alluvium to the north and adjacent to the Rand Mountains. Sixteen shafts from 16 ft. to 50 ft. each have been sunk on this ground. Eleven of these reached bedrock. The bedrock is schist. The gravel is about 12 ft. in thickness. It is unassorted and contains many boulders. In places it is cemented with 'caliche.' The gold occurs evenly distributed throughout the gravel and is reported to vary from 80 cents to $2 per yard in value. Several unsuccessful attempts have been made to work the gravel by dry methods.

The Yellow Channel Mining Company installed the following equipment at two of the shafts: Electric hoist; 2-ton skip to double deck trommel, 4-ft. by 8-ft. to sluice boxes. A 40-ft. Dorr thickener was installed for water recovery.

At the other shaft, a 6-h.p. gas engine hoist, skip to 25-ton bin, 5-ft. by 18-ft. trommel to a 16-ft. sluice box were installed.

Apparently this operation was not successful as the plant is shut down and the machinery is for sale.

Bibl: State Mineralogist's Report XXV, p. 43; Bull. 95, pp. 145–147.

Norman Placer, comprising one claim, is in the north end of the town of Johannesburg. Owners, Charles Norman, Randsburg, California, and G. J. Holohan, Los Angeles. Leased to J. S. Mahood, Red Mountain, California.

This ground is similar to the Norden placer, except that it is 74 ft. to bedrock. The bedrock is schist. Five to six feet of gravel immediately above bedrock is mined and washed. Reported to yield about $2 per yard.

From the bottom of the shaft drifts have been driven 50 ft. southeast and 40 ft. northwest. The pay channel is from 12 ft. to 15 ft. wide.

Equipment consists of 6-in. by 6-in. air compressor belted to a 20-h.p. gas engine and an automobile engine belted to a hoist; 10-ton bin; concrete mixer for breaking the cemented gravel; 18-in. by 3-ft. trommel; 20-ft. by 12-in. sluice; dewatering drag and settling boxes.

Two men are working.

North Sumner Gold Mines, Inc. P. V. Long, president; M. S. Baylor, secretary; R. L. Long, general manager. Office, 203 Merchants Exchange Building, San Francisco. The company has a lease and bond on the following mines in the Cove mining district: Beauregard, North Extension Sumner, Frank, Urbana, Red Hill, Stirrup and Zadel, consisting of 115 acres, located in Sec. 28, T. 25 S., R. 33 E., M. D. M., three-quarters of a mile north of Kernville. Elevation 2860 feet.

There are five veins in the hanging wall granite, known as the Beauregard, Urbana, Frank, Lady Bell–Bull Run and Jeff Davis, which form a junction with the main fissure (Big Blue–Sumner Lode) on the Sumner North Extension Claim. The Beauregard vein strikes N. 75° E., dips 85° NW. and has an average width of four feet. The pay shoot worked is said to be 600 ft. in length with an average width of 3 ft.

The ore is free-milling and plates $20 to $35 per ton. Concentrates are said to average $150 per ton.

Workings consist of seven shafts from 100 ft. to 300 ft. deep, three levels, 2500 ft. of drifts and 6 stopes. The Beauregard shaft is 300 ft. deep, with levels at 100, 200 and 300 feet. On the 200-ft. level the vein has been drifted on 650 ft. to the northeast to a point where the main north and south fault cut the vein off and this fault was drifted on 200 ft. to the north. A crosscut has been driven from this level 200 ft. east into the slate footwall, intersecting the Big Blue-Sumner vein. The Urbana vein strikes N. 50° E., dips 75° NW. and has an average width of 18 inches. Pay shoot is reported to have been 600 ft. long. Workings consist of five shafts 50 ft. to 180 ft. deep, with drifts and stopes. The Frank vein strikes N. 40° E. and dips 77° NW. The vein forms a junction with the Urbana vein about 200 ft. northeast of the Beauregard shaft and also merges with the Beauregard vein on dip and strike to the northeast.

Mine equipment consists of single-drum hoist; 650-cu. ft. Ingersoll-Sargent compressor driven by water turbines; air drills; 2 Cameron pumps; assay office; ore bins and cars.

Mill equipment consists of 10-stamp mill, with 850-pound stamps. Idle.

Bibl: State Mineralogist's Reports XX, pp. 36–40; XIV, pp. 487–488; XXV, pp. 42–43.

Operator Divide Mine (Phoenix). It comprises 7 claims, 140 acres, patented, located in Sec. 35, T. 29 S., R. 40 E., M. D. M., one-half mile north of Johannesburg. Owner, *Operator Consolidated Mines,* 1304 Russ Building, Los Angeles.

Five veins have been developed on the property, strike northwest and southeast, with a dip of 20° northeast. They vary in width from a few inches to 7 feet, the average width being about 2 feet. The formation is schist, although in places rhyolite and diabase dikes occur as the walls of the veins. The ore is oxidized and free-milling. Values vary from a few dollars to $25 per ton.

The principal development is confined to the Phoenix vein on the old Phoenix Mine which was developed by an incline shaft to a depth of 300 ft., with 6 levels and about 2000 ft. of drifts. The property is equipped with a 10-stamp mill. The Phoenix Mine has a record of production of over $600,000. It is reported that 35,000 tons of ore milled had an average value of $17 per ton. Idle.

Operator Divide tailings dump at Johannesburg was worked by Gustav Bender. The sands were dragged into four 17-ton tanks by mules and scrapers. The values were extracted by cyanide solution. Thirty-five hundred tons were treated which yielded about $2 per ton.

Bibl: State Mineralogist's Reports XIV, p. 507; XXV, pp. 43–44. Bull. 95, p. 140.

Opportunity Group of Mines. It comprises four claims situated in the Keyes mining district, three miles southeast of Isabella. Elevation 3500 feet. Owners, H. W. Ross, C. B. Ross and George Ross, Isabella, California.

The vein occurs in granite, strike N. 30° E., dip 60° S.; width 3 inches to 2 feet.

Development consists of incline shaft sunk on vein to a depth of 80 ft. On 28-ft. level there is a drift on vein 40 ft. north; on 48-ft. level, a drift on vein 50 ft. north.

Equipment consists of compressor, hoist and pump. Four men are employed.

Oro Fino Group of Mines. It comprises two claims located on south slope of El Paso range of mountains in the Goler mining district, three miles west of Garlock. Elevation 3600 feet. Owner, Dave Dillon, Garlock, California.

The vein occurs in schist, strike N. 30° W., dip 70° E.; width 18 inches to 2 feet.

Development consists of crosscut tunnel driven southwest 200 ft., with drift north on vein 200 ft. At 200 ft. in elevation above tunnel a shaft has been sunk on the vein to a depth of 30 feet. Idle.

Oro Fino Placer (No. 40), now known as *Olympic and Miller Groups,* comprises 190 acres lying in both Kern and San Bernardino counties, about 7 miles north of Randsburg in the Summit Diggings district. Owners, D. A. Woodruff, 323 South Hancock Street, and C. E. Collins, 2414 Cabot Street, Los Angeles.

On this property the gravels which were deposited by ancient and probably intermittent streams, are reported to be some 18 ft. in thickness. They are unassorted and contain many large boulders. The present operators claim $1.50 per yard average.

In the past much small-scale dry washing has been done here. In the fall of 1923 a large Stebbins dry concentrator was installed. This plant was abandoned after treating some 8000 yards of gravel. Present operations consist of sluicing, water being obtained from a well on one of the claims.

Four men are working.

Bibl: Bull. 95, 'Geology and Ore Deposits of the Randsburg Quadrangle,' p. 147; State Mineralogist's Report XXV, pp. 48–49.

Pennsylvania–Sunrise Group of Mines (Ana–Isabell) (No. 41). This group comprises four claims known as Pennsylvania, Sunrise, High Grande No. 1 and No. 2, situated in the Keyes mining district, in Sec. 35, T. 26 S., R. 32 E., M. D. M., 5 miles south of Isabella. Elevation 3500 feet. Owner, W. B. Walker, Keyesville, California. Under lease and bond to C. B. Kanthier, Los Angeles.

These claims adjoin the Mammoth group of mines on the west. Two parallel veins, known as the Pennsylvania and Sunrise, occur in granite. Strike N. 40° E., dip 70° E. Widths of veins vary from 10 inches to 2 feet.

Developments on the Pennsylvania vein consist of incline shaft sunk on the vein to a depth of 210 ft. About 300 ft. in elevation below the collar of this shaft, a crosscut is being driven northwest to intersect the Pennsylvania vein at a point 300 ft. northeast of the shaft. This tunnel has been advanced 850 ft. in granite. At an elevation of 80 ft. above this tunnel there is a tunnel driven southwest on the Sunshine vein a distance of 800 ft. Ore milled from Pennsylvania vein is stated to carry $150 per ton.

Equipment consists of 160-cu. ft. compressor driven by 60-h.p. Holt gas engine.

Six men are employed.

Bibl: State Mineralogist's Report XXV, p. 45.

Poso Mine (No. 44). It comprises 11 claims located in the Pine Mountain district, in Sec. 30 and 31, T. 27 S., R. 28 E., M. D. M., 22 miles northeast of Bakersfield, on Poso creek. Owners, Poso Mining and Milling Company, Bakersfield, California; W. A. Fritz, president; J. A. Lewis, secretary.

Three parallel veins occur in the granite, striking N. 45° W., and dipping 65° SW. Width of veins is 2 ft. to 4 ft. The ore is free-milling gold quartz with some hematite and pyrite. It also carries values in silver.

Development consists of a shaft sunk on one of the veins to a depth of 147 ft., on an incline of 70°. From Poso creek, a tunnel driven on the vein 865 ft. to the northwest connects with the shaft at a depth of 120 ft., at 365 ft. from the portal. The vein developed in this tunnel shows from 18 inches to 4 feet of oxidized quartz, mineralized with hematite and some iron pyrite. An ore-shoot was developed 210 ft. from the portal of the tunnel which was said to average from $10 to $12 in gold per ton, with some silver values. The length of the pay shoot is 150 ft., with an average width of 2 ft. About 20 ft. southeast of the shaft the vein is cut by a fault that strikes N. 75° E., dipping 40° SE. This fault also cuts the ore-shoot.

Mine equipment: Compressor and air drills; 16-h.p. gas engine hoist. Mill equipment: Blake crusher; 5-ft. Huntington mill; Wilfley concentrator driven by 37½-h.p. Fairbanks-Morse, type Y, Semi-Diesel vertical engine. Idle.

Bibl: State Mineralogist's Report XXV, p. 45.

Queen of Sheba Mine. It comprises four claims situated in the Clear Creek mining district, 2½ miles southeast of Havilah. Elevation 5000 feet. Owner, J. L. Stubblefield, Havilah, California.

A narrow quartz vein occurs in granite, strike NE and SW; dip 80° NW; width 6 inches to 2 feet. Developed by tunnel 200 ft. long.

Two men are employed.

Reform Mine. It comprises two patented claims totaling 40 acres, situated in Secs. 6 and 9, T. 28 S., R. 33 E., M. D. M., in the Valley View mining district and on Erskine Creek, 14 miles southeast of Isabella. Owner, Mrs. Nora D. Coulston, Pasadena.

Quartz vein is in granite; strike N. 30° E., dip 60° E.; width two feet.

Development consists of two tunnels. The lower tunnel is driven on vein 200 ft. and 50 ft. above this tunnel is another tunnel 150 ft. in length. Average value of ore reported to be $3 per ton in gold and 25 ounces in silver. Vein quartz shows ruby silver (cerrargyrite). There is a Huntington mill on the property.

Idle.

Ricardo Placer (No. 46) consisting of approximately 500 acres, lies in Iron Canyon, which is tributary to Red Rock Canyon from the north. The property extends from the mouth of Iron Canyon one mile north to Bonanza Canyon. Owner, Rudolph Hagen, Bakersfield, California. Leased to L. P. Conway, 1236 Amherst Street, West Los Angeles, who has transferred it to the *Iron Canyon Mining Company,* L. E. Wisenberg, North Hollywood, California.

This company installed machinery for the purpose of pumping water with which to hydraulic the hills on the east side of Iron Canyon. They estimated that the ground contained 35 cents per yard. This plan was abandoned when it was found that sufficient water was not available.

The following machinery was installed: two 3-cylinder, 125-h.p. Diesel engines, 75-h.p. generator; two 900-g.p.m. single stage centrifugal pumps; two stage, 10-in. rotary pump, direct connected to 30-h.p. motor.

At time of visit, operations had ceased while company was revising its plan of operation.

Bibl: State Mineralogist's Reports XXV, p. 46; XIII, p. 195; XII, pp. 456–458.

Riveredge Placer Mine (No. 86). It comprises 8 claims situated in the NE¼ of Sec. 19, T. 27 S., R. 32 E., M. D. M., four miles south of Hobo Hot Springs and 13 miles south of Isabella. Owner, Riveredge Mining Company, Ltd.; P. W. Wilson, president; Benjamin Rich, secretary, Los Angeles.

The claims are located along the Kern River, between Greenhorn and Stovepipe gulches, with 3000 ft. along the river channel.

The gravel is reported to carry from 50 cents to $1 per cubic yard. The gold is fine and difficult to recover due to large amount of black sand concentrate.

Four men are employed.

Ruby Mining Company (No. 47) property, consisting of 8 mining claims and Sec. 9, 16 and 17, T. 29 S., R. 31 E., M. D. M., is between Cottonwood Creek and the Kern River, about 15 miles east of Bakersfield. The property comprises about 2080 acres. Elevation approximately 3600 feet. The claims are under lease from George Thatcher, of Bakersfield, by the Ruby Mining Company, Thomas W. McManus, president, 203 Haberfeldt Building, Bakersfield, California.

The property was discovered in the seventies and was formerly known as the *Blue Bell, Montezuma* and *Curly Jim.*

The country rock consists of mica schist which has been intruded by a large mass of quartz diorite. There are numerous veins on this property but the three principal ones are in the schist just to the east of the diorite contact. The San Joaquin is the middle vein and the other two dip toward it. General strike is about N. 30° E., dip approximately 65° SE. A fourth vein, known as the Bobcat, outcrops on the surface to the northwest and its strike indicates that it might intersect the San Joaquin vein about 600 ft. northwest of the winze in the mine. These are all strong veins and in some instances it is known that some of them cross the schist-diorite contact without interruption. They vary up to 8 ft. in width (as now exposed). Vein filling is quartz or quartz stringers in the silicified schist. Mineralization consists of free gold, pyrite, arsenopyrite and chalcopyrite. Some silver values have also been encountered.

There are many open-cuts, shallow shafts and short tunnels scattered over the property. On the Curly Jim there are five old shafts and a 70-ft. tunnel. The deepest shaft is 100 ft. Principal development work consists of a crosscut tunnel east 275 ft. to the vein. The walls are diorite. Drift south 120 ft. to connect with old 90-ft. shaft at face. Some very short lenses of ore were stoped from these old workings. There is also a 40-ft. raise connecting with old workings at 85 ft. from the crosscut. There is also a drift north from the crosscut 100 ft. At 30 ft. there is a stope 15 ft. long, 25 ft. high and about 2½ ft. wide. Ten feet north of the crosscut is the new shaft or winze. This is sunk 120 ft. on a 45° incline. It started in the quartz diorite but is in the contact at the bottom, where it also looks as if two of these veins are coming together, showing a width of 7 ft. No assays had been made on this vein matter but it looks like ore.

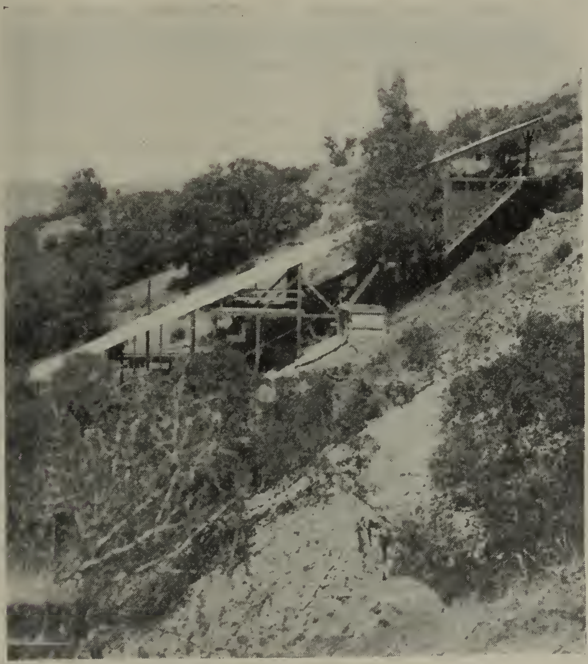

FIG. 8. Five-stamp mill at Ruby Mine, Ruby Mining Company, Bakersfield.

Equipment consists of 120-cu. ft., portable air compressor at the mine; Little Tugger hoist at the winze; at the camp, on the Curly Jim, a 92-cu. ft. compressor driving a duplex pump in the 100 ft. shaft. There is also a triplex pump for raising the water to the mill and a 25-h.p. gas engine.

The mill consists of 50-ton bin, 8-in. by 10-in. Blake type crusher, Challenge feeder; three 750-lb. and two 1050-lb. stamps; two 4-ft. by

4-ft. and three 4-ft. by 10-in. plates; and No. 6 Wilfley table. Power is supplied by 25 h.p. gas engine.

Twelve men are working.

This property appears to have considerable prospective merit.

Sailor Boy Mine (Ben Hur) (No. 48). It comprises four claims located on the northeast slope of Soledad Mountain, in the Mojave mining district, four miles south of Mojave. There are 59 acres, patented, in Sec. 6 and 10, T. 10 and 11 N., R. 12 W. Elevation 3000 feet. Owner, C. C. Moore, Mojave, California.

The vein is from 2 ft. to 3 ft. wide and occurs in rhyolite. The vein strikes N. 20° W. and dips 60° E. A crosscut tunnel has been driven 100 ft. to the vein, with a drift south 200 ft. on the vein, also a drift north for a distance of 50 ft. Near the point where the vein is crosscut, a shoot of ore 40 ft. in length was developed. The ore was stoped to the surface for a distance of 75 ft. It is stated that the ore extracted had an average value of $20 per ton in gold and $10 per ton in silver. Also at this point, a winze was sunk to a depth of 50 ft. Two hundred tons of ore were shipped to the smelter from these workings that gave an average of $20 per ton in gold. Idle.

Bibl: State Mineralogist's Reports XIV, p. 510; XXV, p. 47.

San Antonio Mine (No. 49), comprising 14 claims, is on the east slope of the Piute Mountains about 25 miles north of Mojave. Elevation 4150 feet. Owners, ——— Martino, of Bakersfield, and Mrs. Lee, San Fernando, California. Under lease to San Antonio Mining Company, George Gallaher, 2122 Palm Street, Bakersfield, California.

This is an old property, reported to have been discovered in about 1887, at which time considerable shallow work was done on the property.

The country rock is granodiorite. The vein strikes east-west, dip 85° N. It has been traced on the surface for some 500 ft. Its average width is about 12 inches. Vein filling consists of quartz, replacing the crushed granite, between walls. Mineralization consists of free gold, pyrite and occasional occurrences of galena.

Development consists of four or five old shafts from 50 ft. to 100 ft. deep and present working shaft 120 ft. deep. At the 90-ft. level there is a drift west 103 ft. which connects with the bottom of an old shaft. Also a drift east 60 feet. The first 40 ft. of this east drift was on the vein. There is a small stope 25 ft. long. On the 120-ft. level, drift west 60 ft., east 90 ft. Vein is up to two feet in these workings, from 3 to 8 inches of which is reported to carry values up to $100 per ton.

Nine men are employed erecting ten 1050-lb. stamps, plates and tables. Also sinking a water well one and one-half miles southeast of the mine. This well at 32 ft. is reported to be making 300 gallons per day. The water will have to be raised 500 ft. to a 30,000-gallon reservoir which has been built at the mine.

Bibl: State Mineralogist's Report XXV, p. 47.

Sawyer Mine. It comprises one claim situated in Keyes mining district, in Sec. 35, T. 26 S., R. 32 E., M. D. M., five miles south of

Isabella. Owner, *Mammoth Mountain Mining Company.* Under lease to James Matlock, Isabella, California. Elevation 3500 feet.

This claim is part of Mammoth Group of Claims and located on the Mammoth vein. Vein occurs in granite. Strike NE. and S.W., dip 60° S.; width 6 inches to 2 feet.

Development consists of incline shaft 125 ft. deep sunk on the vein, with drifts on the 100-ft. level. Ore shoot is 70 ft. in length, average width 12 inches. Average value of ore reported to be $70 per ton.

Equipment consists of 6-h.p. gas engine hoist.

Three men are employed.

Shafer and Whitney View Group of Mines. It comprises four claims situated on Kelso Creek, one mile west of Claraville, in Sec. 27, T. 28 S., R. 34 E., M. D. M., 6 miles north of Piute. Elevation 6300 feet. Owner, Herbert Gorman, Piute, California.

The vein occurs in granite, strike northeast and southwest, dip 70° SE.; width two feet.

Development consists of tunnel driven southwest 150 feet. Idle.

Stellar Group of four claims is in the Rademacher district, one-half mile southeast of Indian Valley Wells about 6 miles north of Searles, a station on the Owens Valley branch of the Southern Pacific Railroad. Owners, Ray Young, Mojave, California, and Ross Hand, Burbank, California.

The granitic country rock of these claims is traversed by numerous dikes, principally rhyolite. The strike generally is about N. 30° W. The vein strikes N. 60° E., dips 65° SE. The vein crosses the dikes and the ore occurs at or near these intersections. It is a strong fissure up to four feet wide, averaging about two feet.

Development consists of three shafts 80, 110 and 200 ft. deep. The first two are inaccessible and the 200-ft. shaft is filled to within 80 ft. of the surface. On the 50-ft. level there is a drift southwest 150 ft. This drift shows a continuous shoot of ore 100 ft. long, averaging about 20 inches wide, which is reported to carry $20 per ton.

Five men are employed building an arrastre for treating the ore.

St. John Mine (No. 51). It comprises 7 claims, situated in Sec. 33, T. 28 S., R. 35 E., M. D. M., 20 miles southeast of Weldon and three miles south of Tunnel Springs on the Kelso Valley road. Elevation 5400 ft. Owner, J. H. Copelin, Los Angeles, and Andrew Miller, Weldon, California.

This property was worked in the early seventies by Senator Jones and Senator Stewart, of Nevada. Operations were suspended about the time the Big Blue Mine was discovered in the Cove mining district. Originally there were two mills located near Tunnel Springs. The tailings from these mills were cyanided and it is stated that $7 to $15 per ton in gold was recovered.

Two veins occur in granite, strike N. 50° W. and dip 45° SW. The main vein has an average width of four feet. In the footwall of this vein there is a narrow vein about 6 to 8 inches wide which is said to have produced some very high grade ore.

Development consists of a shaft 600 ft. deep sunk on the vein. About 200 ft. southeast of this shaft there is another shaft 150 ft.

deep which connects with the old stoped area. To the southeast of these workings there are a number of shafts with depths varying from 50 ft. to 100 ft. The vein southeast of the main working appears to be faulted about 150 ft. to the northeast. It is stated that the ore-shoot developed and stoped was 200 ft. in length and had an average width of two feet. Idle.

Bibl: State Mineralogist's Report XXV, p. 48.

Summit Gold Placers (*'Summit Diggings'*) (No. 52). These placers are in Sec. 1 and 12, T. 29 S., R. 40 E., and Sec. 6, T. 29 S., R. 41 E., M. D. M., 6 miles east of Goler and 6 miles north of Randsburg.

In the latter part of 1928 the *Western Placer Mines Company* which controlled most of this ground ceased its operations (see our Report XXV, pp. 48–49). A. L. Cram, on the ground, now owns 1640 acres.

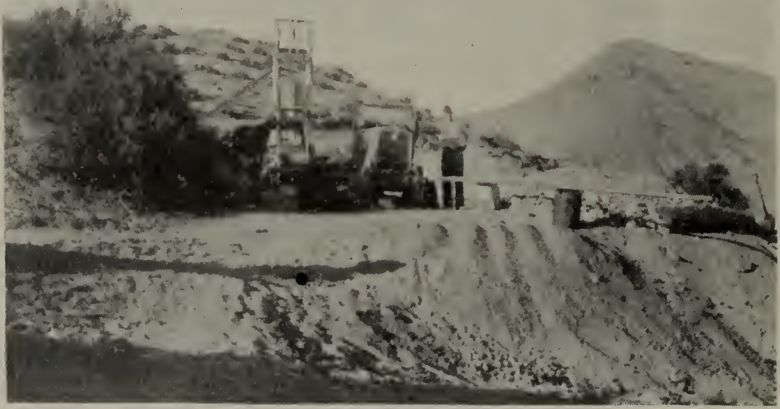

FIG. 9. Headframe and hoist at St. John Mine, Sageland Mining District.

In June, 1932, there were about 50 men working with dry washers in various places on these claims. The owner allowed them to work without payments of royalty to him.

The major portion of the gravels on this ground consists of reconcentrations of the older alluvium in recent water courses and are from 2 ft. to 10 ft. in thickness, containing many large boulders. Present workers confine their operations to the gravel which lies immediately on the bedrock of what appears to be an ancient river bed. The pay gravel is reported to be one to two feet thick, averaging from 75 cents to $1.50 per yard.

Bibl: State Mineralogist's Report XXV, pp. 48–49. Bull. 92, p. 156, 'Gold Placers of California'; Bull. 95, 'Geology and Ore Deposits of the Randsburg Quadrangle,' pp. 147–148.

Sun Group of Mines. It comprises two claims located on the south slope of El Paso range of mountains in Goler mining district, three miles west of Garlock. Elevation 3500 feet. Owner, Sarah Slocum, Garlock, California.

The vein occurs in schist, strike east and west, dip 70° S.; width three feet.

Development consists of tunnel driven west on the vein 600 ft. At 550 ft. west of portal there is a crosscut driven 35 ft. north and 50 ft. south. At 75 ft. west of portal the vein is cut off by a fault which strikes north and south and dips 80° W. The remainder of the tunnel is schist.

Idle.

Sunrise, Jennie Lind and New World Group of Mines (No. 61). This group comprises three patented claims, 60 acres, situated in Sec. 10, T. 28 S., R. 32 E., M. D. M., in Clear Creek mining district, one miles west of Havilah. Elevation 3600 to 4200 feet. Owner, Mrs. Hallah Miller, Havilah, California.

A series of parallel NE. and SW. quartz veins occur in the granite. Development consists of a number of tunnels driven at different elevations on the different veins. Tunnels vary from 100 ft. to 600 ft. in length. Veins vary in width from 12 inches to 2 feet. Idle.

Sunshine Mine (No. 53). It consists of 40 acres, patented, in Sec. 11, T. 30 S., R. 40 E., M. D. M., in the Stringer district, one and one-half miles south of Randsburg. Elevation 4000 feet. Owner, T. W. Atkinson Estate, 201 North Holly Avenue, Compton, California. Under lease to E. B. Bleekenstaff, Red Mountain, California.

Two quartz veins known as the Sunshine and LaCrosse occur in the schist. The principal development is confined to the Sunshine vein, which strikes N. 80° E. and stands vertical. The vein is from 6 to 12 inches wide, free-milling gold quartz. The course of the albite schist in this area is N. 10° E. The Sunshine vein is cut by a number of faults which offset the vein a short distance. On the 400-ft. level, at 57 ft. west of the shaft, it is cut by a fault which dips 50° SE. At 230 ft. east of the shaft a north-south vein intersects the Sunshine vein. This vein follows a vertical fault.

Development consists of a shaft 600 ft. deep, with levels driven at 100, 200, 300, 400 and 500 ft. and approximately 1000 ft. of drifts.

Mine equipment consists of 25-h.p. hoists, air compressor and blacksmith shop and dwellings. Mill equipment comprises three stamps and cyanide plant. The production has been $1,000,000.

Three men employed.

Bibl: State Mineralogist's Reports XIV, p. 512; XXV, p. 49.

Surprise Group of Mines comprises three claims situated in Sec. 29, T. 28 S., R. 34 E., M. D. M., in Green Mountain mining district, nine miles north of Piute. Elevation 7000 feet. Owner, A. O. Griswald, Piute, California.

Three parallel veins occur in granite, strike N. 40° E., dip 70° SE.; widths 8 inches to 2 feet.

Development consists of shallow shafts along different vein outcrops and two tunnels 100 ft. in length.

Two men are employed.

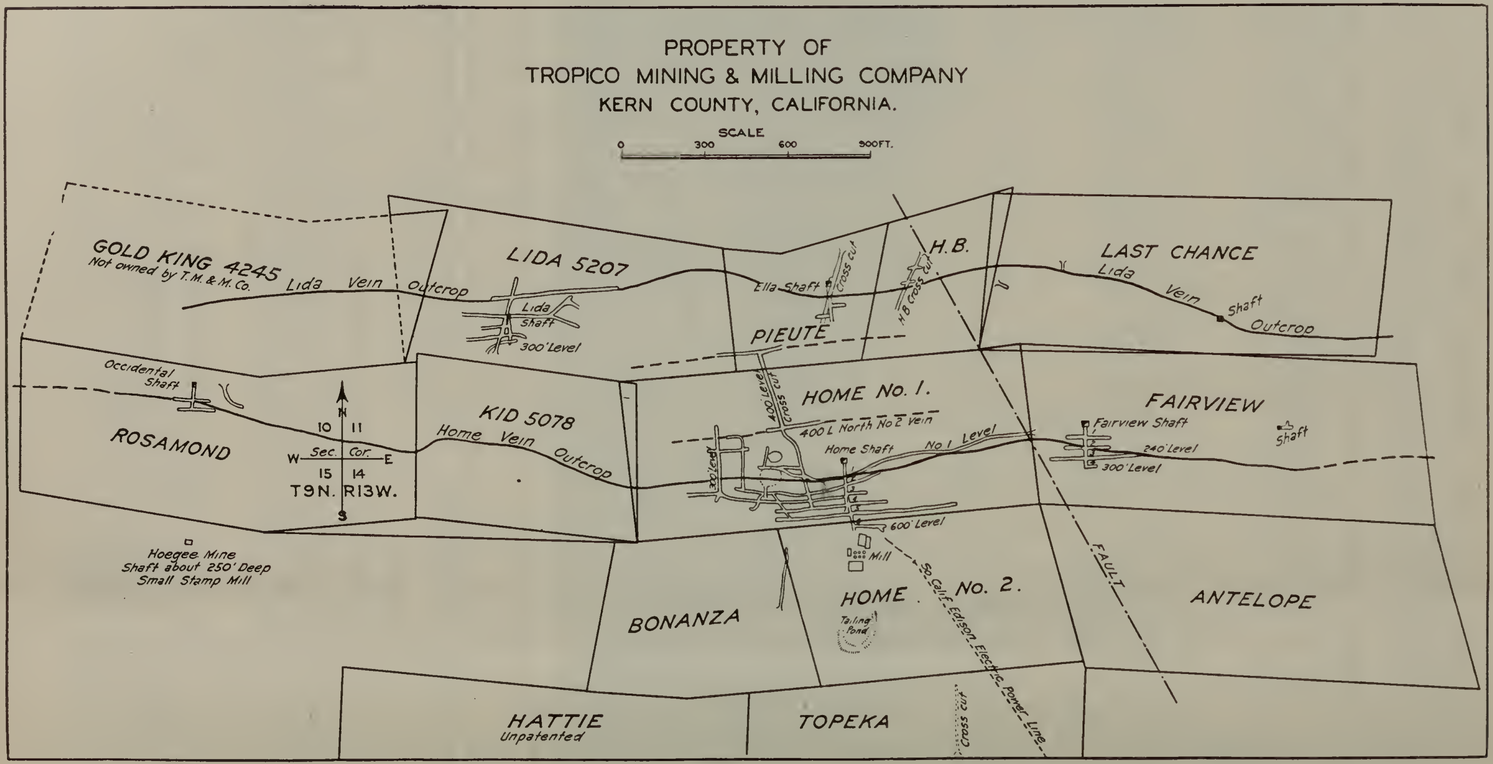
PROPERTY OF
TROPICO MINING & MILLING COMPANY
KERN COUNTY, CALIFORNIA.
SCALE
0
300
600
900FT.
GOLD KING 4245
Not owned by T.M. & M. Co.
Lida Vein Outcrop
LIDA 5207
Lida Shaft
300' Level
Ella Shaft
Cross cut
H.B.
H B Cross cut
PIEUTE
LAST CHANCE
Lida Vein
Shaft
Outcrop
Occidental Shaft
ROSAMOND
10
11
N
Sec. Cor.
W
E
15
14
T9N. R13W.
S
KID 5078
Home Vein Outcrop
400' Level
Cross cut
HOME No. 1.
400 L North No 2 Vein
Home Shaft
No 1 Level
300' Level
600' Level
Mill
FAIRVIEW
Fairview Shaft
240' Level
300' Level
Shaft
FAULT
Hoegee Mine
Shaft about 250' Deep
Small Stamp Mill
BONANZA
HOME No. 2.
Tailing Pond
So. Calif. Edison Electric Power Line
ANTELOPE
HATTIE
Unpatented
TOPEKA
Cross cut

FIG. 10.

Tropico Mines (No. 54). It comprises 11 patented claims, 220 acres, and two 5-acre mill sites, situated in Sec. 10, 11, 14 and 15, T. 9 N., R. 13 W., S. B. M., five miles northwest of Rosamond. Elevation 2800 feet. Owner, Tropico Mining and Milling Company; Clifford Burton, president; E. H. Cockran, secretary, Los Angeles.

The vein system consists of 6 parallel veins that follow fault fissures in rhyolite. These veins strike east and west, dip 60° S. and have widths varying from 6 ft. to 10 ft.

Development work consists of shafts sunk on the Home, Fairview and Lida veins. This vein system is cut by a series of north and south faults that dip 45° W. The principal development work is on the Home claim. Here the main shaft has been sunk on an incline of 60° to a depth of 700 ft. At 80 ft. in elevation below the collar of the shaft, the main haulage tunnel is driven 150 ft. north to vein, with a drift 350 ft. west of the shaft to a glory hole. On this level a drift has been run east on the Home vein several hundred feet. The oreshoot developed on this level was 150 ft. in length, with an average width of 6 ft. Average value of ore extracted is said to have been from $5 to $10 per ton in gold. There are seven levels driven on the vein at 100-ft. intervals. Ore-shoot west of shaft was 150 ft. in length, with an average width of 6 ft. and has been stoped from the fifth level to the surface. A shoot of ore was developed east of the shaft on the seventh level and has been stoped for a length of 150 ft. to No. 3 level. Crosscuts have been driven west of the shaft on No. 2, No. 3, No. 5 and No. 6 levels to No. 1 vein, which has been stoped from No. 6 level to No. 2 level for a length of 100 ft., average width being four feet. About 150 ft. west of shaft on No. 3 level, a crosscut has been driven north 700 ft. to the Lida vein. The Fairview shaft is located 1000 ft. east of the Main shaft and sunk on an incline of 60° to a depth of 300 ft.

Mine equipment consists of 50-h.p. electric hoist; 320-cu.ft. Chicago pneumatic compressor driven by 75-h.p. motor; Deane duplex pump on 600-ft. level, driven by 30-h.p. motor, capacity 70 gallons per minute. Mill equipment consists of ten 1000-pound stamps, driven by 30-h.p. motor; 30-ton cyanide plant.

During the past two years the company has been treating the ore extracted from the Exposed Treasure Mine. Six men are employed.

> Bibl: State Mineralogist's Reports XIV, p. 512; XXV, pp. 50–51.

Uncle Sam Mine (*Southern Cross*) (No. 62), consists of 7 claims totaling 140 acres, situated in Sec. 3 and 4, T. 28 S., R. 32 E., M. D. M., in Clear Creek mining district, two miles west of Havilah. Elevation 4200 feet. Owner, Mrs. Ella M. West and L. L. Porter, Havilah, California.

Three parallel veins occur in granite, strike NE. and SW.; dip 70° S. The main vein has a width of 6 ft. to 20 ft. and shows a massive outcrop of quartz which can be traced for a distance of 3000 ft. on the surface.

Development consists of lower tunnel driven southwest in the hanging wall of vein. At an elevation of 71 ft. above this tunnel, the upper tunnel is driven as a crosscut 350 ft. northwest. At 75 ft. from

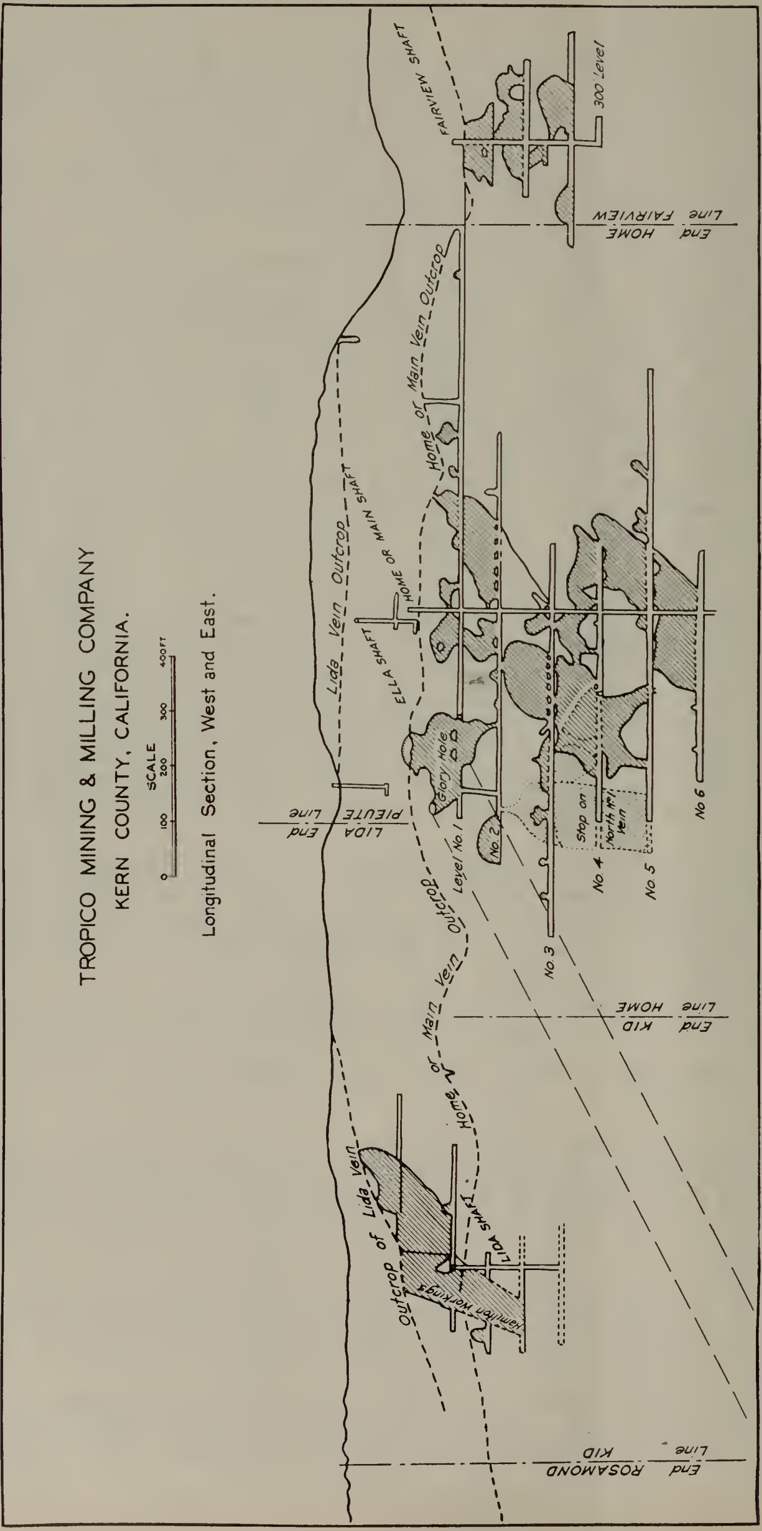
TROPICO MINING & MILLING COMPANY
KERN COUNTY, CALIFORNIA.
SCALE
0 100 200 300 400FT
Longitudinal Section, West and East.
FAIRVIEW SHAFT
300' Level
End HOME Line FAIRVIEW
Home or Main Vein Outcrop
Lida Vein Outcrop
HOME OR MAIN SHAFT
ELLA SHAFT
Glory Hole
End LIDA PIEUTE Line
Level No. 1
No. 2
No. 3
No. 4
No. 5
No 6
Stop on North No. 1 Vein
Home or Main Vein Outcrop
End KID HOME Line
Outcrop of Lida Vein
LIDA SHAFT
Hamilton Workings
End ROSAMOND KID Line

FIG. 11.

the portal cut No. 1 vein which has been drifted on northeast 230 ft. At 270 ft. northwest of this vein No. 2 vein was intersected by a crosscut tunnel and drifted on 300 ft. NE. This vein has an average width of three feet. The vein material is oxidized gold quartz, mineralized with pyrite and arsenopyrite. It is stated samples taken at intervals along the two veins developed carry values of $6 to $20 per ton in gold.

Equipment consists of compressor, air drills, cars and track.

Three men are employed driving lower tunnel to intersect winze from upper tunnel on No. 1 vein.

Bibl: State Mineralogist's Reports XIV, p. 510; XXV, p. 47.

Wall Street Mine. It comprises three claims located one mile south of the Bright Star Mine in Sec. 18, T. 28 S., R. 34 E., M. D. M. Elevation 8000 feet. Owner, Edward Doble, Piute, California.

Vein occurs in slate; strike NE. and SW., dip 70° S.; width 6 to 12 inches. Shaft 70 feet deep.

Equipment 40-h.p. hoist; 40-h.p. boiler; two No. 5 Cameron pumps. Idle.

Warrington Mine (No. 63). It comprises one claim of 20 acres situated in Sec. 9 and 10, T. 28 S., R. 32 E., M. D. M., in Clear Creek mining district, one mile west of Havilah. Elevation 4000 feet. Owners, S. L. Simmons and S. F. McDonald, Havilah, California. Under lease and bond to John Fluhart, Wasco, California. This property was formerly one of the principal producers of the Havilah district and had a 10-stamp mill and cyanide plant.

The vein strikes northeast and southwest and dips 70° SE. Width of vein varies from 2 ft. to 6 ft.; average width of vein 4 ft. Vein quartz is mineralized with free gold, pyrite and arsenopyrite. Value of ore reported to be from $6 to $20 per ton in gold. It is stated that from 1000 tons of ore mined from winze from main tunnel level, a recovery of $17,000 was made. Production is reported to have been $50,000. Development:

No. 1 tunnel	100 ft.
No. 2 tunnel	260 ft.
No. 3 tunnel (Lower tunnel)	450 ft.

At 260 ft. southwest of the portal of lower tunnel there is a winze 300 ft. deep sunk on the vein with levels at 100, 200 and 300 ft. Oreshoot developed in these workings is 260 ft. in length with an average width of 4 ft. of quartz mineralized with pyrite and arsenopyrite. At mouth of No. 3 tunnel level, there is a shaft sunk on an incline of 45° in the footwall to a depth of 325 ft., with levels at 100, 200 and 300 ft. On 300 ft. level there is a crosscut 41 ft. to vein, with drift on the vein 460 ft. to the southwest. Ore developed in these workings is said to be a heavy sulphide.

Equipment consists of two boilers; steam hoist and steam engine which operated mill. Mine workings caved. Idle.

White Mine (Sidney). This property is located in Sec. 16 and 17, T. 30 S., R. 40 E., M. D. M., on the southeast slope of the Rand Mountains, about four miles southwest of Randsburg. Holdings comprise 260 acres. Owner, A. C. White, Randsburg, California.

A series of veins occur in the Rand schist. The strike is about N. 55° E., dip 65° to 70° to the southeast. The veins vary in width from 12 inches to 2 feet. The vein filling consists of quartz and silicified schist. The values occur as free gold and vary from $10 to $100 per ton.

Property is developed by two shafts, one 85 ft., the other 275 ft. deep. These are about 600 ft. apart and are connected on the 85-ft. level. In the 275-ft. shaft, drifts have been driven as follows:

70-ft. level E. 125 ft., W. 20 ft.
100-ft. level E. 125 ft., W. 350 ft.
150-ft. level E. 85 ft., W. 525 ft.
200-ft. level E. 50 ft., W. 450 ft.
275-ft. level E. 100 ft., W. 500 ft.

Crosscuts between the three veins exposed in these workings add about 1000 ft. to the above development. The principal ore-shoot was stoped for a length of 260 ft. on the 100-ft. level. The stope is from 2 ft. to 6 ft. wide. It was also stoped from 150-ft. to 100-ft. level. On the 150 and 200-ft. levels, three veins or three branches of the same vein have been worked. The footwall branch is the strongest and it was in this branch that the stoping has been done. The ore-shoots occur at or in the vicinity of the intersection of the vein with a rhyolite dike.

It is reported that a considerable tonnage of $5 ore remains in the mine; also several thousand tons on the dump reported to carry the same values. Past production is reported at $250,000 from ore which averaged $26 per ton.

Equipment consists of hoist, air compressor, blacksmith shop and dwellings.

Nearest available water is at Randsburg. Idle.

Bibl: State Mineralogist's Report XXV, p. 51.

White Star Group of claims is in the Rademacher district about one mile north of the Huntington mine and about 8 miles northwest of Searles, a station on the Owens Valley branch of the Southern Pacific Railroad. Owners, P. Erdman and Son, Inyokern, California.

It is reported that a 60-ft. shaft has been sunk on a vein in the granite and that this vein is up to 8 ft. in width. Not visited.

Idle except for assessment work.

Whitmore Mine (No. 85). It comprises 10 claims totaling 160 acres, situated in Sec. 32, T. 11 N., R. 12 W., S. B. M., three and one-half miles south of Mojave in Mojave mining district. Elevation 2700 feet. Owner, W. K. Whitmore and J. E. Whitmore, Mojave, California.

Four parallel veins occur along a series of roughly parallel rhyolitic-porphyry dikes. The general course of these porphyry dikes is N. 30° W., dip 60° E. The veins strike north to N. 30° W. and dip 60° E. Their widths vary from 2 ft. to 6 ft.

Development consists of two shafts, one being sunk on the most westerly vein to a depth of 300 ft., on an incline of 75°, with levels at 100 ft. and 200 ft. This shaft is sunk on the vein for a distance of 225 ft., then vertically for 75 ft. in the footwall. The vein developed on these two levels has an average width of three feet and is reported to carry values in gold and silver from $6 to $50 per ton. The other shaft is an incline shaft 100 ft. deep. The vein developed is from

2 ft. to 4 ft. wide. The ore is free-milling, containing some pyrite. Average value is reported to vary from $10 to $20 per ton.

Equipment consists of 6-h.p. gas engine hoist; 10-in. by 10-in. compressor driven by 30-h.p. gas engine; shops and dwellings. Two men are employed.

Bibl: State Mineralogist's Reports XIX, pp. 152–163; XXV, p. 52.

Windy Mine. It comprises 90 acres situated in Sec. 34, T. 29 S., R. 40 E., M. D. M., in the Rand district, one mile northeast of Randsburg. Elevation 3800 ft. Owners, T. C. Welch, 629 Washington Building, Los Angeles; H. C. Marsh, 1637 Two Hundred and Twenty-first St., Torrance, California. Under lease and bond to *International Mining and Milling Company,* I. G. Ilseng, president, 183 North Martel St., Los Angeles.

Several parallel veins occur in the schist. The ore is free-milling and, as formerly mined, reported to be high grade.

Development consists of an incline shaft 225 ft. deep and crosscut 100 ft. on 200-ft. level, with a winze 100 ft. in depth. Levels have been driven on the vein at 50, 100, 150 and 200 ft, with several thousand feet of drifts. Ore extracted by former operators is reported to have carried from $20 to $40 per ton in gold.

The present lessees have mined some 200 tons from the 200-ft. level and treated it in the King Solomon mill with a reported recovery of about $8 per ton.

Equipment at the Windy consists of 40-ton Joshua Hendy rod mill, amalgamation plates, concentrator and cyanide plant.

Ten men are employed.

Bibl: State Mineralogist's Reports XIV, p. 513; XXV, pp. 51–52.

Yellow Aster Mine (No. 55). This property is the largest gold producer in Kern County and one of the oldest mines in the Randsburg district. The total production of the mine is estimated to have been about $10,000,000. Of this amount, approximately $3,000,000 has been paid in dividends. The property comprises 47 patented claims and 6 unpatented claims, totaling 796 acres, situated in Sec. 2, 3, 34 and 35, T. 29 and 30 S., R. 40 E., M. D. M., in the Rand mining district, about one mile west of Randsburg. The property has been under operation since 1896. Owner, Yellow Aster Mining and Milling Company; Albert Ancker, president; Arthur Asher, vice-president; Dr. Rose L. Burcham, secretary; W. F. Allen, general manager. Offices, 602 Transportation Building, Los Angeles. Under lease and bond to the *Anglo-American Mining Corporation*; Henry W. Klipstein, president; A. W. Frolli, manager, 1005 Mills Building, San Francisco, California.

The orebody is a network of quartz veins and stringers in quartz monzonite and schist. The gold occurs both in these veins of quartz and stringers and in the quartz-monzonite adjacent to the veins. The present low-grade orebody consists of a triangular block of mineralized quartz monzonite, which is bounded on the east by the Hanging Wall Fault, on the north by the Jupiter Fault and on the southwest by the Footwall Fault. This orebody is about 800 ft. in width, 1000 ft. in length and was worked down to the third level. There are 6 parallel veins that have been developed in this area which strike northwest and southeast. The dips vary from 30° northeast to vertical. The Jupiter Fault strikes N. 75° E., dipping to the north at an angle of 40°; the Hanging Wall Fault strikes N. 30° W., dipping 45° NE.; the Footwall Fault strikes N. 60° W., dipping 40° NE. The high-grade orebodies formerly mined occurred along vertical fissures and fracture zones and also beneath the low-dipping premineral faults which bound the present low-grade orebody on the north and east. The vertical orebodies strike northwest and vary in width from small veins to over 75 ft. The largest orebodies occurred in the northwest fissures and fracture zones and had a length of about 800 ft. and a thickness of 20 ft. to 75 ft. The Rand vertical vein was worked for a length of 500 ft., and had an average width of 15 ft. It was worked to a depth of 400 ft. The Price vein was worked for a length of 500 ft. The average width was 10 ft. and it was mined to a depth of 400 ft. The orebodies that occur as mineralized zones underlying the pre-mineral faults possess well-defined hanging walls formed by the gouge along the fault. This ore is composed of mineralized country rock usually quartz monzonite and schist, with very little vein quartz. Orebodies of this type occurred beneath Jupiter Fault, along the line of the midway tunnel. They were from 200 ft. to 300 ft. in length and varied from 4 ft. to 16 ft. in thickness. The ore extracted from these rich veins is stated to have had a value of from $25 to $50 per ton. The estimated tonnage of the low-grade oxidized ore that constitutes the present orebody is stated to be four million tons, with a gross value of $1.75 per ton. A new orebody has been developed on the north side of the glory hole along the Jupiter

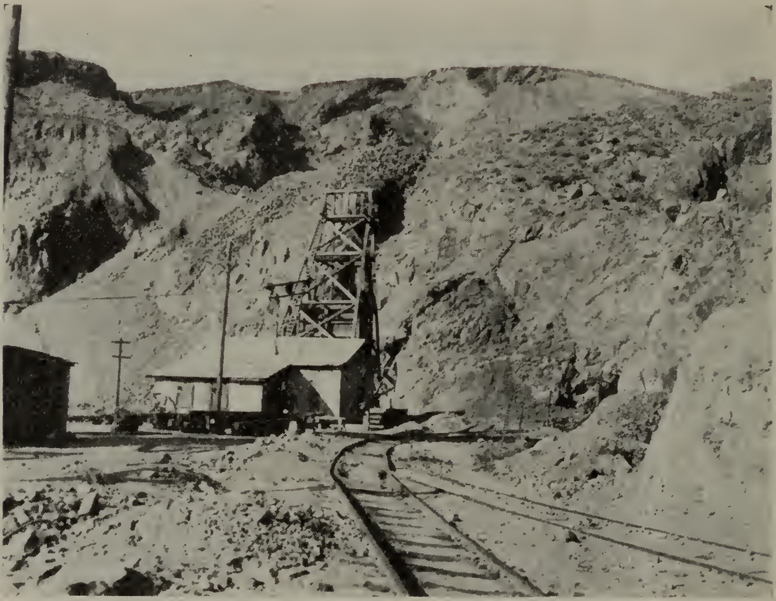

FIG. 12. Glory hole at Rand shaft of Yellow Aster Mine, Randsburg.

Fault about 100 ft. in elevation about the Rand level. A tunnel has been driven southwest 300 ft. At 100 ft. southwest of the portal, a shoot of ore was encountered which has been developed for 200 ft. in length. The vein varies in width from 4 ft. to 13 ft. It strikes northeast and dips 30° to 35° to the north. The footwall is quartz-monzonite. On the footwall there is a carbonized gouge 6 to 12 inches thick. The mineralized quartz occurs above the gouge. Average value of the ore extracted is reported to be $6 per ton. Several raises have been put up in this shoot of ore for a distance of 115 ft. The past months mill run on ore from this orebody showed a recoverable value of $5.50 per ton. The principal development work under way at the time the property was visited was confined to raises above the Rand level in blocks of ground above the floor of the glory hole. Some development was being done on the 100 ft. and 300-ft levels on the Prince vein.

Mine workings: The mine is developed by approximately 15 miles of workings and three shafts. The workings are distributed among 14 levels, of which the Rand level, the first, second and third levels are the most important. Three shafts have been sunk from the floor of the glory hole. The main shaft is sunk on an incline of 45° to a depth of 250 ft. The shaft follows down the footwall fault. The Hercules shaft is sunk on an incline of 40° to a depth of 450 ft. and located between the Jupiter and Hanging Wall faults. The Rand vertical shaft is located 150 ft. southwest of the Hercules shaft and has been sunk to a depth of 450 ft. At the time of the writer's visit to the property, in May, 1933, the mining was done partly on company account and by a system of leasers. Ten leases were being worked in the mine, two men composing the party working each lease. Leases within the mine are given on the basis of a 50% royalty, on ore running $10 and above. The company furnishes tools and air. The leasers furnish their own powder and load the ore on cars.

FIG. 13. Fifty-stamp mill at Yellow Aster Mine, Randsburg.

Since the above was written the mine has passed into the hands of the lessee and all underground leases have been discontinued. The mill has been shut down and is now being remodeled. It is planned to crosscut the ore-bearing formations on the levels below the glory hole in order that the tonnage and value of the entire mass may be ascertained.

Mine equipment consists of one Chicago pneumatic compressor; one Norwalk compressor; 30 three-ton ore cars; three electric hoists; air drills; blacksmith and machine shops.

Mill equipment: A 4-ton Plymouth locomotive hauls a train of 3-ton cars from the mine on the Rand level to crushing and screening plant. From storage bin with a capacity of several hundred tons, the ore is fed to a No. 4 Gates gyratory crusher, after which it is screened at one inch, oversize to waste dump by belt conveyor. Screenings by conveyor to mill bins, to fifty 1000-lb. stamps. Ore is crushed to 40-mesh and pulp flows over amalgamation plates thence to Dorr duplex classifier, sands to waste, overflow to two batteries of Kraut flotation cells; one battery containing six, the other five cells. Tests have shown that the fines contain 85 per cent of the values in the pulp.

This plant is to be used as a test or pilot plant. Ore from development work underground will be treated and final flow sheet for a larger mill will be thus definitely worked out.

Seventy men are now employed.

> Bibl: State Mineralogist's Reports XIV, p. 514; XXV, pp. 53–54. Bull. 95, Geology and Ore Deposits of the Randsburg Quadrangle, pp. 121–125.

Yellow Dog Mine (No. 56). It comprises 8 claims, totaling approximately 160 acres, of which 29 acres are patented, located in Secs. 29, 32, T. 11 N., R. 12 W., S. B. M., three miles south of Mojave. Owner, Yellow Dog Mining Company; P. O. Paulson, president; Walter Kibby, secretary; Bert Fisher, vice president; H. C. Burton, manager. Offices, 715 Hibernian Building, Los Angeles.

During the early part of 1922, Percy Wegman of Mojave, discovered an outcrop of quartz carrying free gold on this group of claims. This discovery of high grade gold ore was the most important made in the district in recent years and caused a revival of interest in the district. The vein strikes north and dips 60° to the east. It has an average width of 6 ft., with a maximum width of 10 ft. The high grade gold quartz occurs on the hanging wall, with a vein of spar from 6 ft. to 8 ft. wide, heavily stained with manganese on the footwall. The vein occurs on the eastern slope of a small butte of rhyolite-porphyry. It is stated that samples taken from the spar vein will average $3 per ton, while the average value of samples from four feet of vein quartz was better than $25 per ton.

Development: At an elevation of 2800 ft., a shaft has been sunk on an incline of 60° to a depth of 300 ft. Levels have been driven at 100, 200 and 300 ft. From the 100-ft. level to the 300-ft. level, the shaft is in the footwall of the vein, which is granite. The orebody developed between the 100-ft. level and the surface is 200 ft. in length and has an average width of 6 ft. This shoot of ore is located north of the shaft. On the 300-ft. level this ore-shoot was cut 280 ft. north of the shaft. At this point a winze has been sunk to a depth of 30 feet.

At 120 feet north of shaft, a crosscut was driven 300 ft. west in the footwall in the hopes of intersecting a parallel vein. In 1927, 576 tons of ore was treated in the Tropico Mining Company's mill which had an average value of $30 per ton. The total production is reported as $70,000.

Mine equipment consists of 15-h.p. electric hoist; 10-in. by 12-in. Chicago pneumatic compressor driven by 50-h.p. motor. Electric power is secured from the Southern California Edison Company.

Six men are employed.

Under lease to E. L. Wegman, Mojave, California. Ore is milled in 2-stamp mill.

Bibl: State Mineralogist's Reports XIX, pp. 163–164; XXV, p. 55.

Yellow Treasure Group of five claims is in the Rademacher district, five and one-half miles north of Searles, a station on the Owens valley branch of the Southern Pacific Railroad. Owner, A. DeMayo, on the ground.

The vein accompanies a rhyolite dike in the granite. Strike varies from N. 35° W. to N. 50° W., dip 78° NE. The vein also crosses the dike and the ore forms at or near this intersection. Width of vein varies from 3 ft. to 6 ft. Vein filling consists of quartz, mineralized with hematite, chalcopyrite, bornite and free gold.

Development consists of a 60-ft. shaft with a drift south 20 ft. on the 40-ft. level. Several hundred feet to the northwest is a 40-ft. shaft. In the bottom of this shaft the vein is five feet wide, with well defined walls of rhyolite. About two feet of this vein matter, on the footwall side, is well mineralized and looks like good ore. No accurate idea of values was obtained.

Idle except for assessment work.

Zenda Mine (No. 57). It comprises 900 acres, located in Sec. 30, T. 30 S., R. 33 E., M. D. M., in the Amalie mining district, 14 miles northeast of Caliente. Elevation 3000 to 3500 feet. Owner, Zenda Gold Mining Company, 1214 Pacific Mutual Bldg., Los Angeles; W. C. Browning, president; T. R. Drummond, secretary.

The vein occurs as a massive outcrop of quartz in quartz-porphyry, strikes northeast and dips 35° N. The width of the vein varies from 30 ft. to 50 ft. and where exposed in the glory hole, it has a width of 50 ft. The known pay shoot is 300 ft. in length, with an average width of 30 ft.

Workings consists of a number of tunnels from 150 ft. to 600 ft. in length and two glory holes. The main tunnel haulage is driven N. 30° W. about 350 ft., from which point an upraise connects with the glory hole. The ore mined from the glory hole has a value of $3 per ton, carrying 0.08 ounces in gold and 3.5 ounces in silver. Mill equipment consists of 150-ton cyanide plant.

The property was operated from August 1, 1923, until September, 1927, when operations were suspended. The Zenda Gold Mining Company has acquired holdings in the Calico district, San Bernardino County. The company plans to ship all mining and mill equipment from the Zenda Mine to Calico. Idle.

Bibl: State Mineralogist's Reports XIV, p. 515; XX, pp. 41–42; XXV, p. 55.

GEOLOGIC BRANCH

CURRENT NOTES

By Olaf P. Jenkins, Chief Geologist

Although the two geological papers listed below are ready for publication in the California Journal of Mines and Geology, insufficient funds prevent them from appearing in this issue (July-October, 1933). It is intended that they will be published in a subsequent number of the Journal.

Geology and Mineral Deposits of Northeastern Madera County, California, by Homer Erwin.

Geology and Mineral Deposits of Laurel and Convict Basins, Southwestern Mono County, California, by Evans B. Mayo.

OIL FIELD DEVELOPMENT OPERATIONS

R. D. Bush, State Oil and Gas Supervisor

From April 2, 1933, to and including July 1, 1933, the following new wells were reported as ready to drill:

Company	Sec.	Twp.	Range	Well No.	Field
COLUSA COUNTY:					
W. T. Jacobs	31	15 N.	4 W.	4	
James Kassik	27	14 N.	5 W.	1	
FRESNO COUNTY:					
Champion Oil & Transport Co., Ltd.	27	21 S.	17 E.	Iowa 1	Kettleman North Dome
Kettleman North Dome Assoc.	28	21 S.	17 E.	2	Kettleman North Dome
Union Oil Co.	29	21 S.	17 E.	King 4	Kettleman North Dome
Dana Hogan	28	20 S.	16 E.	Ladd Fee 1	
Russ Oil Syn.	28	12 S.	11 E.	1	
Western Gulf Oil Co.	15	17 S.	15 E.	S. P. Land 1	
GLENN COUNTY:					
Tehama Petroleum Corp.	10	22 N.	5 W.	Murdock-Simpson 1	
KERN COUNTY:					
Belridge Oil Co.	27	27 S.	20 E.	48–27	Belridge
Continental Oil Co.	36	27 S.	20 E.	Result 4	Belridge
Lincoln Petroleum Corp., Ltd.	10	25 S.	18 E.	Alferitz 1	Devils Den
Cascade Oil Co.	23	29 S.	27 E.	Hasson 2	Fruitvale
H. S. Dumke	21	29 S.	27 E.	Dumke-Camel 1	Fruitvale
Kernco Oil Co., Ltd.	23	29 S.	27 E.	1	Fruitvale
Kernco Oil Co., Ltd.	23	29 S	27 E.	2	Fruitvale
Charles B. Maxwell	21	29 S.	27 E.	Maxwell 1	Fruitvale
W. D. Stanfield & Wm. F. Schweikert	21	29 S.	27 E.	SS 21–2	Fruitvale
W. T. W. Petroleum Corp.	23	29 S.	27 E.	Neff 1	Fruitvale
L. L. White & Associates	6	30 S.	28 E.	NC 1	Fruitvale
Frank Goldman and E. P. Hoisington	32	27 S.	27 E.	Grimes 4	Kern River
General Petroleum Corp.	10	30 S.	21 E.	Lovitt 1	McKittrick
Honolulu Oil Corp., Ltd.	8	32 S.	24 E.	35	Midway
Honolulu Oil Corp., Ltd.	8	32 S.	24 E.	54	Midway
Honolulu Oil Corp., Ltd.	8	32 S.	24 E.	57	Midway
Honolulu Oil Corp., Ltd.	8	32 S.	24 E.	65	Midway
Honolulu Oil Corp., Ltd.	14	32 S.	24 E.	23	Midway
Honolulu Oil Corp., Ltd.	14	32 S.	24 E.	27	Midway
Honolulu Oil Corp., Ltd.	14	32 S.	24 E.	63	Midway
Joseph McDonald	26	31 S.	22 E.	18	Midway
Bern Oil Co., Ltd.	15	27 S.	28 E.	Glide 1	Mt. Poso
Ekoh Oil Co.	4	27 S.	28 E.	Ekoh-Vedder 1	Mt. Poso
Himovitz Oil Co.	21	27 S.	28 E.	1	Mt. Poso
Himovitz Oil Co.	21	27 S.	28 E.	2	Mt. Poso
Isler & Turk	28	26 S.	28 E.	1	Mt. Poso
Pongratz Petroleum Co.	10	27 S.	28 E.	Pongratz-Tavis 2	Mt. Poso
Shell Oil Co.	9	27 S.	28 E.	Vedder 7	Mt. Poso
Shell Oil Co.	9	27 S.	28 E.	Vedder 8	Mt. Poso
Shell Oil Co.	16	27 S.	28 E.	Security 7	Mt. Poso
Bankline Oil Co.	4	31 S.	29 E.	Symons 1	Mountain View
Barnsdall Oil Co.	30	30 S.	29 E.	R. L. Noble 1	Mountain View
Barnsdall Oil Co.	31	30 S.	29 E.	Mott 1	Mountain View
Barnsdall Oil Co.	31	30 S.	29 E.	Steavens 1	Mountain View
Barnsdall Oil Co.	31	30 S.	29 E.	B. H. Young 1	Mountain View
Barnsdall Oil Co.	31	30 S.	29 E.	L. J. Young 1	Mountain View
Barnsdall Oil Co.	32	30 S.	29 E.	Morris 1	Mountain View
A. T. Jergins Trust	29	30 S.	29 E.	C. F. Moore 1	Mountain View
A. T. Jergins Trust	30	30 S.	29 E.	A. E. Wright & C. W. Bloemer 1	Mountain View
Long Beach Petroleum Co., Ltd.	29	30 S.	29 E.	Vedder-Petrol 1	Mountain View
Long Beach Petroleum Co., Ltd.	29	30 S.	29 E.	Vedder-Petrol 2	Mountain View
Long Beach Petroleum Co., Ltd.	29	30 S.	29 E.	Vedder-Petrol 3	Mountain View
Mohawk Petroleum Co.	30	30 S.	29 E.	Clendennen 1	Mountain View
Mohawk Petroleum Co.	30	30 S.	29 E.	Hood 2	Mountain View
Plymouth Oil Co.	29	30 S.	29 E.	1	Mountain View
Shell Oil Co.	29	30 S.	29 E.	Porter-Day 2	Mountain View
Shell Oil Co.	29	30 S.	29 E.	Porter-Day 3	Mountain View
Shell Oil Co.	29	30 S.	29 E.	Porter-Day 4	Mountain View
Shell Oil Co.	29	30 S.	29 E.	Porter-Day 5	Mountain View
Shell Oil Co.	29	30 S	29 E.	Porter-Day 6	Mountain View
Shell Oil Co.	30	30 S.	29 E.	Cowan 1	Mountain View
Shell Oil Co.	32	30 S.	29 E.	Bahrenburg 1	Mountain View
Shell Oil Co.	32	30 S.	29 E.	Porter Two 1	Mountain View
Shell Oil Co.	32	30 S.	29 E.	Porter Two 2	Mountain View
California Western Oil Co., Ltd.	12	28 S.	28 E.	1	Round Mountain
Helm & Bailey	1	28 S.	28 E.	Coffee 2	Round Mountain
Howells Brothers	32	28 S.	29 E.	Howells 1-A	Round Mountain
E. L. Blanck and Chas. Munding	6	11 N.	23 W.	2	Sunset

OIL FIELD DEVELOPMENT OPERATIONS—Continued

Company	Sec.	Twp.	Range	Well No.	Field
KINGS COUNTY:					
Kettleman North Dome Assoc.	8	22 S.	18 E.	56	Kettleman North Dome
Standard Oil Co.	35	21 S.	17 E.	36	Kettleman North Dome
A. Manford Brown Kettleman City Oil & Gas Co.	2	23 S.	19 E.	3	
Magee and Stone	33	24 S.	22 E.	2	
Western Natural Resource Corp. & E. B. Guess	20	22 S.	22 E.	1	
LOS ANGELES COUNTY:					
Plymouth Oil Co.	24	3 S.	11 W.	1	Coyote Hills
Republic Petroleum Co., Ltd.	34	3 S.	13 W.	Republic-Childs 4	Dominguez
Shell Oil Co.	34	3 S.	13 W.	Reyes 44	Dominguez
Shell Oil Co.	34	3 S.	13 W.	Reyes 45	Dominguez
Sunrise Petroleum Co.	3	4 S.	13 W.	1	Dominguez
Union Oil Co.	33	3 S.	13 W.	Callender 31	Dominguez
Union Oil Co.	33	3 S.	13 W.	Hellman 22	Dominguez
Allied Petroleum Corp.	24	4 S.	13 W.	10	Long Beach
Atascadero Oil Co.	20	4 S.	12 W.	Willett 1	Long Beach
Beach Petroleum Corp., Ltd.	19	4 S.	12 W.	3	Long Beach
Beloil Corp., Ltd.	24	4 S.	13 W.	Van Cleave 2	Long Beach
R. R. Bush Oil Co.	20	4 S.	12 W.	Fee 1	Long Beach
R. R. Bush Oil Co.	20	4 S.	12 W.	Fee 2	Long Beach
R. R. Bush Oil Co.	29	4 S.	12 W.	I. P. C. 1	Long Beach
R. R. Bush Oil Co.	29	4 S.	12 W.	I. P. C. 2	Long Beach
Dabney-Johnston Oil Corp.	24	4 S.	13 W.	88	Long Beach
Davis Investment Co.	29	4 S.	12 W.	20	Long Beach
Davis Investment Co.	29	4 S.	12 W.	21	Long Beach
D. D. Dunlap	30	4 S.	12 W.	7	Long Beach
Ellroy Petroleum Corp.	24	4 S.	13 W.	Ellroy 1	Long Beach
Exeter Oil Co., Ltd.	18	4 S.	12 W.	Noll 4	Long Beach
Exeter Oil Co., Ltd.	19	4 S.	12 W.	Noll 5	Long Beach
Exeter Oil Co., Ltd.	24	4 S.	13 W.	Noll 3	Long Beach
Edward Gieck	19	4 S.	12 W.	Reggio 1	Long Beach
Edward Gieck	19	4 S.	12 W.	Reggio 2	Long Beach
The Hancock Oil Co.	20	4 S.	12 W.	Signal 32	Long Beach
Locust Oil Co.	24	4 S.	13 W.	Mun 1	Long Beach
V. R. G. Wilbur	19	4 S.	12 W.	Bergstrom 3	Long Beach
Wood-Callahan Oil Co., Ltd.	29	4 S.	12 W.	12	Long Beach
Woolner Oil Corp., Ltd.	24	4 S.	13 W.	L. B. Fee 2	Long Beach
Charles T. Lester	17	3 N.	16 W.	1-A	Newhall
Bachman Petroleum Corp.	28	2 S.	15 W.	Venice 2	Playa del Rey
The Texas Co.	13	2 S.	12 W.	Pico 1	
ORANGE COUNTY:					
Bartholomae Oil Corp.	22	3 S.	10 W.	Stern 1	Coyote Hills
Bartholomae Oil Corp.	22	3 S.	10 W.	Stern 2	Coyote Hills
Bartholomae Oil Corp.	22	3 S.	10 W.	Stern 3	Coyote Hills
Bartholomae Oil Corp.	22	3 S.	10 W.	Stern 4	Coygte Hills
Standard Oil Co.	18	3 S.	10 W.	Murphy-Coyote 113	Coyote Hills
Beloil Corp., Ltd.	10	6 S.	11 W.	H. B. 1	Huntington Beach
Beloil Corp., Ltd.	10	6 S.	11 W.	H. B. 2	Huntington Beach
Camroo Oil Co.	10	6 S.	11 W.	Smith 1	Huntington Beach
Hammil Oil Corp.	10	6 S.	11 W.	Lewis 2	Huntington Beach
Lindberg & Laughlin	10	6 S.	11 W.	1	Huntington Beach
E. F. Richards	10	6 S.	11 W.	1	Huntington Beach
Richrow Corp.	10	6 S.	11 W.	Severns 2	Huntington Beach
Sierra Huntington Oil Co., Inc.	10	6 S.	11 W.	2	Huntington Beach
Simaroo Oil Co.	10	6 S.	11 W.	Morris 1	Huntington Beach
Simaroo Oil Co.	10	6 S.	11 W.	Morris 2	Huntington Beach
Socal Oil Co.	10	6 S.	11 W.	Lowder 1	Huntington Beach
W. K. Co.	10	6 S.	11 W.	1	Huntington Beach
Wilshire Oil Co., Inc.	10	6 S.	11 W.	H. B. 15	Huntington Beach
Wilshire Oil Co., Inc.	10	6 S.	11 W.	H. B. 16	Huntington Beach
Wilshire Oil Co., Inc.	10	6 S.	11 W.	H. B. 17	Huntington Beach
Wilshire Oil Co., Inc.	10	6 S.	11 W.	H. B. 18	Huntington Beach
Wilshire Oil Co., Inc.	10	6 S.	11 W.	H. B. 19	Huntington Beach
Wilshire Oil Co., Inc.	10	6 S.	11 W.	H. B. 20	Huntington Beach
Wilshire Oil Co., Inc.	10	6 S.	11 W.	H. B. 21	Huntington Beach
Wilshire Oil Co., Inc.	10	6 S.	11 W.	H. B. 22	Huntington Beach
Wilshire Oil Co., Inc.	10	6 S.	11 W.	H. B. 23	Huntington Beach
Wilshire Oil Co., Inc.	10	6 S.	11 W.	H. B. 24	Huntington Beach
Wilshire Oil Co., Inc.	10	6 S.	11 W.	H. B. 25	Huntington Beach
Wilshire Oil Co., Inc.	10	6 S.	11 W.	H. B. 26	Huntington Beach
Wilshire Oil Co., Inc.	10	6 S.	11 W.	H. B. 28	Huntington Beach
Wilshire Oil Co., Inc.	10	6 S.	11 W.	H. B. 29	Huntington Beach
Wilshire Oil Co., Inc.	10	6 S.	11 W.	H. B. 30	Huntington Beach
Wilshire Oil Co., Inc.	10	6 S.	11 W.	H. B. 31	Huntington Beach
Wilshire Oil Co., Inc.	10	6 S.	11 W.	H. B. 32	Huntington Beach

OIL FIELD DEVELOPMENT OPERATIONS—Continued

Company	Sec.	Twp.	Range	Well No.	Field
ORANGE COUNTY—Continued					
W. F. Brown	26	3 S.	9 W.	1	Richfield
Crystal Gasoline Corp.	28	3 S.	9 W.	3	Richfield
Otis Hoyt	28	3 S.	9 W.	16	Richfield
Imperial Gypsum & Oil Corp.	27	3 S.	9 W.	1	Richfield
Long Beach Petroleum Co., Ltd.	28	3 S.	9 W.	Mann 3	Richfield
SAN BERNARDINO COUNTY:					
C. F. McCarthy et al.	14	3 N.	6 W.	1	----
SAN LUIS OBISPO COUNTY:					
J. D. Martin	5	32 S.	13 E.	Pricco A 3	Arroyo Grande
SANTA BARBARA COUNTY:					
Golconda Petroleum Corp.	9	8 N.	32 W.	Shaw 3	Cat Canyon
Golconda Petroleum Corp.	9	8 N.	32 W.	Shaw 4	Cat Canyon
Golconda Petroleum Corp.	9	8 N.	32 W.	Shaw 5	Cat Canyon
Golconda Petroleum Corp.	9	8 N.	32 W.	Shaw 6	Cat Canyon
Golconda Petroleum Corp.	9	8 N.	32 W.	Tognazzini 1	Cat Canyon
Golconda Petroleum Corp.	9	8 N.	32 W.	Tognazzini 3	Cat Canyon
Bankline Oil Co.	15	4 N.	29 W.	89–10	Elwood
Barnsdall Oil Co.	15	4 N.	29 W.	88–9A	Elwood
Caroline C. Spalding	16	4 N.	29 W.	Blue Goose 93 7	Elwood
Fair View Oil Co.	18	7 N.	34 W.	2	Lompoc
Meganos Oil Co.	28	8 N.	34 W.	2	Lompoc
Fred Cole	28	4 N.	27 W.	Knott 2	Mesa
Fred Cole	28	4 N.	27 W.	Stewart Comm. 1	Mesa
R. H. McIntosh Co.	28	4 N.	27 W.	McIntosh-Clark 1	Mesa
Monterey Exploration Co	----	5 N.	31 W.	1	----
Standard Oil Co.	20	4 N.	28 W.	Chase & Bryce 1	----
TEHAMA COUNTY:					
Irwin S. Burgess	12	28 N.	7 W.	1	----
VENTURA COUNTY:					
Knieper and Atha	7	3 N.	19 W.	Dryden 1	Bardsdale
William A. Kirk	21	4 N.	22 W.	5	Ojai
R. E. Struve	12	4 N.	22 W.	4	Ojai
Bardeen Petroleum Co., Ltd.	13	4 N.	19 W.	3-B	Piru
Oil Ridge Oil Co.	1	4 N.	19 W.	3	Piru
Imperial Gypsum & Oil Corp.	32	5 N.	19 W.	1	Sespe
Williamson & Danaher	36	3 N.	18 W.	1	Simi
Los Cerritos Petroleum Co., Ltd.	17	3 N.	20 W.	1	South Mountain
Associated Oil Co.	22	3 N.	23 W.	Hartman 14	Ventura
Associated Oil Co.	27	3 N.	23 W.	Lloyd 134	Ventura
Shell Oil Co.	29	3 N.	23 W.	Taylor 76	Ventura

OIL FIELD DEVELOPMENT OPERATIONS—Continued

From July 2, 1933, to and including September 30, 1933, the following new wells were reported as ready to drill:

Company	Sec.	Twp.	Range	Well No.	Field
COLUSA COUNTY:					
Smith and Vickers	32	15 N.	4 W.	1	
FRESNO COUNTY:					
Kettleman North Dome Assoc.	20	21 S.	17 E.	78	Kettleman North Dome
Kettleman North Dome Assoc.	28	21 S.	17 E.	76	Kettleman North Dome
Kettleman North Dome Assoc.	20	21 S.	17 E.	85	Kettleman North Dome
Kettleman North Dome Assoc.	32	21 S.	17 E.	41	Kettleman North Dome
Kettleman North Dome Assoc.	2	22 S.	17 E.	72	Kettleman North Dome
Standard Oil Co.	19	21 S.	17 E.	38	Kettleman North Dome
Standard Oil Co.	27	21 S.	17 E.	8	Kettleman North Dome
Standard Oil Co.	27	21 S.	17 E.	58	Kettleman North Dome
Standard Oil Co.	1	22 S.	17 E.	45	Kettleman North Dome
Bergman Oil Co.	13	12 S.	11 E.	2	
Bergman Oil Co.	13	12 S.	11 E.	6	
Bergman Oil Co.	13	12 S.	11 E.	7	
Bergman Oil Co.	14	12 S.	11 E.	3	
Bergman Oil Co.	22	12 S.	11 E.	8	
Bergman Oil Co.	26	12 S.	11 E.	14	
Bergman Oil Co.	18	12 S.	12 E.	5	
Bergman Oil Co.	19	12 S.	12 E.	10	
David L. Roscoe	36	16 S.	14 E.	1	
Superior Oil Co.	6	22 S.	16 E.	Mantes 1	
KERN COUNTY:					
H. L. Eibe and E. W. King	25	25 S.	18 E.	3-A	Devils Den
Caribou-Record Co.	11	28 S.	27 E.	Caribou-Record 1	Kern River
Caribou-Record Co.	11	28 S.	27 E.	Caribou-Record 2	Kern River
Caribou-Record Co.	11	28 S.	27 E.	Caribou-Record 3	Kern River
Frank Goldman and E. P. Herrington	32	27 S.	27 E.	Grimes 4	Kern River
Honolulu Oil Corp., Ltd.	14	32 S.	24 E.	15	Midway
Honolulu Oil Corp., Ltd.	14	32 S.	24 E.	43	Midway
Honolulu Oil Corp., Ltd.	14	32 S.	24 E.	76	Midway
A. L. Bergere	11	27 S.	28 E.	1	Mt. Poso
A. L. Bergere	11	27 S.	28 E.	2	Mt. Poso
A. L. Bergere	15	27 S.	28 E.	5	Mt. Poso
Bern Oil Co., Ltd.	15	27 S.	28 E.	Glide 2	Mt. Poso
Bern Oil Co., Ltd.	15	27 S.	28 E.	Glide 3	Mt. Poso
Bern Oil Co., Ltd.	15	27 S.	28 E.	Glide 4	Mt. Poso
Bern Oil Co., Ltd.	15	27 S.	28 E.	Glide 5	Mt. Poso
Bishop Oil Co.	28	26 S.	28 E.	Bishop 1	Mt. Poso
E. J. Burns	10	27 S.	28 E.	1	Mt. Poso
California Western Oil Co., Ltd.	23	27 S.	27 E.	2	Mt. Poso
General Petroleum Corp.	16	27 S.	28 E.	Heisen 37	Mt. Poso
General Petroleum Corp.	16	27 S.	28 E.	Heisen 47	Mt. Poso
General Petroleum Corp.	21	27 S.	28 E.	Glide 21 1	Mt. Poso
Isler & Turk	28	26 S.	28 E.	1	Mt. Poso
Edward R. Richter	15	27 S.	28 E.	Glide 2	Mt. Poso
George W. Shearer	28	26 S.	28 E.	1	Mt. Poso
Bishop Oil Co.	31	30 S.	29 E.	Ward 1	Mountain View
Earl Fruit Co.	4	31 S.	29 E.	1	Mountain View
Earl Fruit Co.	4	31 S.	29 E.	2	Mountain View
Earl Fruit Co.	10	31 S.	29 E.	1	Mountain View
P. H. Greer Co., Inc.	9	31 S.	29 E.	Perrel 1	Mountain View
Hogan Petroleum Co.	32	30 S.	29 E.	Wharton 4	Mountain View
Long Beach Petroleum Co., Ltd.	6	31 S.	29 E.	Blair 1	Mountain View
Long Beach Petroleum Co., Ltd.	6	31 S.	29 E.	Blair 2	Mountain View
Plymouth Oil Co.	29	30 S.	29 E.	1	Mountain View
Shell Oil Co.	29	30 S.	29 E.	Porter-Day 7	Mountain View
Shell Oil Co.	29	30 S.	29 E.	Porter-Day 8	Mountain View
Shell Oil Co.	30	30 S.	29 E.	San Joaquin Dev. Co. 1	Mountain View
Shell Oil Co.	30	30 S.	29 E.	San Joaquin Dev. Co. 2	Mountain View
George Snyder	24	30 S.	28 E.	Aris 1	Mountain View
Superior Oil Co.	25	30 S.	28 E.	Burns 1	Mountain View
Superior Oil Co.	25	30 S.	28 E.	Burns 2	Mountain View
Superior Oil Co.	25	30 S.	28 E.	F. Clendennen 1	Mountain View
Superior Oil Co.	25	30 S.	28 E.	F. Clendennen 2	Mountain View
Superior Oil Co.	25	30 S.	28 E.	F. Clendennen 3	Mountain View
Superior Oil Co.	25	30 S.	28 E.	W. H. Clendennen 1	Mountain View
Superior Oil Co.	25	30 S.	28 E.	W. H. Clendennen 2	Mountain View
Superior Oil Co.	32	30 S.	29 E.	Clark 1	Mountain View
Superior Oil Co.	32	30 S.	29 E.	Clark 2	Mountain View
Superior Oil Co.	32	30 S.	29 E.	Clark 3	Mountain View
Superior Oil Co.	32	30 S.	29 E.	Clark 4	Mountain View
The Vega Corp.	24	30 S.	28 E.	Vega 1	Mountain View
The Vega Corp.	24	30 S.	28 E.	Vega 2	Mountain View

OIL FIELD DEVELOPMENT OPERATIONS—Continued

Company	Sec.	Twp.	Range	Well No.	Field
KERN COUNTY—Continued					
Vesta Petroleum Co., Ltd.	25	30 S.	28 E.	7	Mountain View
Vesta Petroleum Co., Ltd.	25	30 S.	28 E.	8	Mountain View
Golden Bear Oil Co., Ltd.	6	28 S.	29 E.	Rex Oil Co. 1	Round Mountain
The Kern River Oilfields of California, Ltd.	13	28 S.	28 E.	Kernco 4	Round Mountain
Shamrock Petroleum Corp.	6	28 S.	29 E.	4	Round Mountain
Signal Oil and Gas Co.	8	11 N.	23 W.	Signal Wallace 3	Sunset
S. T. Alexander	29	25 S.	21 E.	Alexander 1	
The Ohio Oil Co.	31	31 S.	26 E.	Kern County Land Co. 1	
Union Oil Co.	15	30 S.	28 E.	Mountain View 1	
KINGS COUNTY:					
Kettleman North Dome Assoc.	36	22 S.	18 E.	36	Kettleman North Dome
Commonwealth Consolidated Gas, Ltd.	21	22 S.	20 E.	1	
Dudley Dome Oil & Gas Co.	9	23 S.	20 E.	2	
LOS ANGELES COUNTY:					
Republic Petroleum Co., Ltd.	34	3 S.	13 W.	Republic-Childs 5	Dominguez
Shell Oil Co.	33	3 S.	13 W.	Reyes 46	Dominguez
Shell Oil Co.	33	3 S.	13 W.	Reyes 47	Dominguez
Shell Oil Co.	33	3 S.	13 W.	Reyes 48	Dominguez
Shell Oil Co.	34	3 S.	13 W.	Reyes 49	Dominguez
Shell Oil Co.	34	3 S.	13 W.	Reyes 50	Dominguez
Union Oil Co.	32	3 S.	13 W.	Callender 42	Dominguez
Union Oil Co.	33	3 S.	13 W.	Callender 32	Dominguez
Union Oil Co.	33	3 S.	13 W.	Callender 33	Dominguez
Union Oil Co.	33	3 S.	13 W.	Callender 34	Dominguez
Union Oil Co.	33	3 S.	13 W.	Callender 35	Dominguez
Union Oil Co.	33	3 S.	13 W.	Callender 36	Dominguez
Union Oil Co.	33	3 S.	13 W.	Callender 37	Dominguez
Union Oil Co.	33	3 S.	13 W.	Callender 38	Dominguez
Union Oil Co.	33	3 S.	13 W.	Callender 39	Dominguez
Union Oil Co.	33	3 S.	13 W.	Callender 40	Dominguez
Union Oil Co.	33	3S.	13 W.	Callender 41	Dominguez
Union Oil Co.	33	3 S.	13 W.	Carson 6	Dominguez
Union Oil Co.	33	3 S.	13 W.	Hellman 23	Dominguez
Union Oil Co.	33	3 S.	13 W.	Hellman 24	Dominguez
Union Oil Co.	33	3 S.	13 W.	Hellman 25	Dominguez
Union Oil Co.	33	3 S.	13 W.	Hellman 26	Dominguez
Union Oil Co.	33	3 S.	13 W.	Hellman 27	Dominguez
Union Oil Co.	33	3 S.	13 W.	Hellman 29	Dominguez
Union Oil Co.	33	3 S.	13 W.	Hellman 30	Dominguez
Union Oil Co.	33	3 S.	13 W.	Hellman 31	Dominguez
Union Oil Co.	33	3 S.	13 W.	Hellman 32	Dominguez
Union Oil Co.	33	3 S.	13 W.	Hellman 33	Dominguez
Union Oil Co.	33	3 S.	13 W.	Hellman 34	Dominguez
Union Oil Co.	33	3 S.	13 W.	Hellman 35	Dominguec
Union Oil Co.	33	3 S.	13 W.	Hellman 36	Dominguez
Union Oil Co.	33	3 S.	13 W.	Hellman 37	Dominguez
Union Oil Co.	33	3 S.	13 W.	Hellman 38	Dominguez
Union Oil Co.	34	3 S.	13 W.	Hellman 28	Dominguez
R. R. Bush Oil Co.	20	4 S.	12 W.	Fee 3	Long Beach
Davis Investment Co.	29	4 S.	12 W.	22	Long Beach
C. H. De Leske	24	4 S.	13 W.	3	Long Beach
Equitable Oil Co.	19	4 S.	12 W.	Equitable 2	Long Beach
Exeter Oil Co., Ltd.	29	4 S.	12 W.	Fee 1	Long Beach
James Oil Co., Ltd.	29	4 S.	12 W.	Kreyssler 1	Long Beach
J. E. O'Donnell	28	4 S.	12 W.	O'Donnell 71	Long Beach
Richfield Oil Co.	29	4 S.	12 W.	Denni 9	Long Beach
San Lucas Oil Co., Ltd.	30	4 S.	12 W.	2	Long Beach
West American Oil Co.	19	4 S.	12 W.	12	Long Beach
West American Oil Co.	19	4 S.	12 W.	13	Long Beach
V. R. G. Wilbur	19	4 S.	12 W.	Bergstrom 4	Long Beach
M. K. Nance	6	2 S.	11 W.	1	Montebello
The St. Helens Petroleum Co., Ltd.	6	2 S.	11 W.	Piuma-Briano 6	Montebello
The St. Helens Petroleum Co., Ltd.	2	2 S.	12 W.	Monterey 19	Montebello
The St. Helens Petroleum Co., Ltd.	2	2 S.	12 W.	Monterey 20	Montebello
The St. Helens Petroleum Co., Ltd.	2	2 S.	12 W.	Monterey 21	Montebello
Standard Oil Co.	1	2 S.	12 W.	Baldwin 72	Montebello
Universal Consolidated Oil Co.	6	2 S.	11 W.	A-1	Montebello
Universal Consolidated Oil Co.	6	2 S.	11 W.	C-2	Montebello
Universal Consolidated Oil Co.	6	2 S.	11 W.	R-1	Montebello
W. L. Alexander	1	3 N.	16 W.	Alexander 2	Newhall
Edward Oil Co.	23	3 N.	16 W.	1	Newhall
F. E. Keeler	14	3 N.	16 W.	Yangna 1	Newhall
F. E. Keeler	14	3 N.	16 W.	Yangna 2	Newhall
The Ohio Oil Co.	28	2 S.	15 W.	Recreation Gun Club 13	Playa del Rey
Union Oil Co.	27	2 S.	15 W.	King Vidor 4	Playa del Rey
Myrwane Petroleum Co.	20	3 S.	13 W.	Bradford 1	Rosecrans

OIL FIELD DEVELOPMENT OPERATIONS—Continued

Company	Sec.	Twp.	Range	Well No.	Field
LOS ANGELES COUNTY—Continued					
Shell Oil Co.	6	3 S.	11 W.	Slusher 28	Santa Fe Springs
Union Oil Co.	5	3 S.	11 W.	Farwell 16	Santa Fe Springs
Delaney Petroleum Corp.	3	5 S.	12 W.	Daly 2	Seal Beach
Pacific Development Co.	16	3 S.	13 W.	Saulque 1	
Pacific Oil Investment Co., Ltd.	28	4 S.	13 W.	Lupie 2	
Pacific Oil Investment Co., Ltd.	14	5 S.	14 W.	1	
MERCED COUNTY:					
Bergman Oil Co.	1	12 S.	11 E.	11	
Bergman Oil Co.	1	12 S.	11 E.	15	
Bergman Oil Co.	1	12 S.	11 E.	16	
Bergman Oil Co.	4	12 S.	11 E.	12	
Bergman Oil Co.	9	12 S.	11 E.	13	
Bergman Oil Co.	14	12 S.	11 E.	4	
Bergman Oil Co.	22	12 S.	11 E.	9	
ORANGE COUNTY:					
Graham-Loftus Oil Corp.	13	3 S.	10 W.	2	Coyote Hills
Graham-Loftus Oil Corp.	13	3 S.	10 W.	3	Coyote Hills
Si Rubens	19	3 S.	9 W.	Tuffree 1	Coyote Hills
Standard Oil Co.	18	3 S.	10 W.	Murphy-Coyote 114	Coyote Hills
E. K. Allison Syn.	10	6 S.	11 W.	McClure 1-A	Huntington Beach
Ambassador Petroleum Co.	10	6 S.	11 W.	H. B. 8-A	Huntington Beach
American Petroleum Corp.	10	6 S.	11 W.	2	Huntington Beach
Beloil Corp., Ltd.	10	6 S.	11 W.	H. B. 3	Huntington Beach
Byrens Oil Co.	10	6 S.	11 W.	2	Huntington Beach
Charles W. Camp	10	6 S.	11 W.	Laughlin 2	Huntington Beach
Crude Oil Drilling Co., Ltd.	10	6 S.	11 W.	1	Huntington Beach
Doyle Petroleum Corp.	10	6 S.	11 W.	1	Huntington Beach
Doyle Petroleum Corp.	10	6 S.	11 W.	2	Huntington Beach
Doyle Petroleum Corp.	10	6 S.	11 W.	3	Huntington Beach
Equitable Oil Co.	34	5 S.	11 W.	Morris-Fowler 1	Huntington Beach
Equitable Oil Co.	35	5 S.	11 W.	Towers 3	Huntington Beach
Huntington Signal Oil Co.	10	6 S.	11 W.	F-8	Huntington Beach
M. & H. Oil Corp.	10	6 S.	11 W.	M. & H. Harris 3	Huntington Beach
W. E. McCaslin	10	6 S.	11 W.	17-A	Huntington Beach
Minnesota Oil Co.	10	6 S.	11 W.	Smith 1	Huntington Beach
A. J. Odell	10	6 S.	11 W.	1	Huntington Beach
The Petrol Corp.	10	6 S.	11 W.	Brooks 1	Huntington Beach
The Petrol Corp.	10	6 S.	11 W.	Hook-Schram 1	Huntington Beach
The Petrol Corp.	10	6 S.	11 W.	Larson 1	Huntington Beach
The Petrol Corp.	10	6 S.	11 W.	Towers 1	Huntington Beach
The Petrol Corp.	10	6 S.	11 W.	Towers 2	Huntington Beach
The Petroleum Co.	10	6 S.	11 W.	Huntington Beach Fee 2	Huntington Beach
The Petroleum Co.	10	6 S.	11 W.	Huntington Beach Fee 3	Huntington Beach
The Petroleum Co.	10	6 S.	11 W.	Huntington Beach Fee 4	Huntington Beach
Plymouth Oil Co.	10	6 S.	11 W.	H. B. 1	Huntington Beach
Reading Oil Corp.	10	6 S.	11 W.	Reading-Anderson 1	Huntington Beach
E. F. Richards & T. M. Rowan	10	6 S.	11 W.	Rimmer 1	Huntington Beach
Rosemar Oil Co., Inc.	10	6 S.	11 W.	Rosemar 1	Huntington Beach
Southern Oil Co.	10	6 S.	11 W.	1	Huntington Beach
Speik Oil Co.	10	6 S.	11 W.	Speik 4	Huntington Beach
Speik Oil Co.	10	6 S.	11 W.	Speik 5	Huntington Beach
Raldo Exploration Co.	10	6 S.	11 W.	Raldo 1	Huntington Beach
W. F. Schweikert	10	6 S.	11 W.	1	Huntington Beach
Smith & Dea	10	6 S.	11 W.	Keeler 2	Huntington Beach
Smith & Dea	10	6 S.	11 W.	Keeler 3	Huntington Beach
Southern California Drilling Co.	10	6 S.	11 W.	Severns 3	Huntington Beach
Standard Oil Co.	10	6 S.	11 W.	Huntington B 64	Huntington Beach
Standard Oil Co.	10	6 S.	11 W.	Huntington B 66	Huntington Beach
Standard Oil Co.	10	6 S.	11 W.	P. E. 17	Huntington Beach
Standard Oil Co.	10	6 S.	11 W.	P. E. 18	Huntington Beach
Standard Oil Co.	10	6 S.	11 W.	P. E. 19	Huntington Beach
Superior Oil Co.	10	6 S.	11 W.	Berry 2	Huntington Beach
Superior Oil Co.	10	6 S.	11 W.	Chudnow 2	Huntington Beach
Superior Oil Co.	10	6 S.	11 W.	Gilmore 2	Huntington Beach
Superior Oil Co.	10	6 S.	11 W.	Groves 2	Huntington Beach
Superior Oil Co.	10	6 S.	11 W.	Huntington Beach Fee 14	Huntington Beach
Superior Oil Co.	10	6 S.	11 W.	Huntington Beach Fee 16	Huntington Beach
The Termo Co.	10	6 S.	11 W.	Fee 2	Huntington Beach
The Termo Co.	10	6 S.	11 W.	Fee 4	Huntington Beach
The Termo Co.	10	6 S.	11 W.	Fee 5	Huntington Beach
Tide Petroleum Co.	10	6 S.	11 W.	1	Huntington Beach
Tide Petroleum Co.	10	6 S.	11 W.	2	Huntington Beach

OIL FIELD DEVELOPMENT OPERATIONS—Continued

Company	Sec.	Twp.	Range	Well No.	Field
ORANGE COUNTY—Continued					
Two and One Oil Co., Ltd.	10	6 S.	11 W.	Two and One 4	Huntington Beach
West American Oil Co.	34	5 S.	11 W.	Morris-Fowler 1	Huntington Beach
West Coast Exploration Co., Ltd.	10	6 S.	11 W.	West Coast 1	Huntington Beach
West Coast Refining Co.	10	6 S.	11 W.	W. C. 1	Huntington Beach
West Coast Refining Co.	10	6 S.	11 W.	W. C. 2	Huntington Beach
Western States Drilling Co.	10	6 S.	11 W.	Humphrey 1	Huntington Beach
Western States Drilling Co.	10	6 S.	11 W.	Huston-Humphrey 1	Huntington Beach
P. W. Willett Trust	10	6 S.	11 W.	Willett 2	Huntington Beach
Wilshire Oil Co., Inc.	10	6 S.	11 W.	H. B. 7-A	Huntington Beach
Wilshire Oil Co., Inc.	10	6 S.	11 W.	H. B. 8-A	Huntington Beach
Wilshire Oil Co., Inc.	10	6 S.	11 W.	H. B. 9-A	Huntington Beach
Wilshire Oil Co., Inc.	10	6 S.	11 W.	H. B. 33	Huntington Beach
Windsor Oil Co.	10	6 S.	11 W.	Culbertson 1	Huntington Beach
Windsor Oil Co.	10	6 S.	11 W.	Culbertson 2	Huntington Beach
Woodward Oil Co.	10	6 S.	11 W.	Ames 2	Huntington Beach
Delaney Petroleum Corp.	28	3 S.	9 W.	Olsen 1	Richfield
Otis Hoyt	28	3 S.	9 W.	17	Richfield
Long Beach Petroleum Co., Ltd.	28	3 S.	9 W.	Holloman 1	Richfield
Long Beach Petroleum Co., Ltd.	28	3 S.	9 W.	Holloman 2	Richfield
Long Beach Petroleum Co., Ltd.	28	3 S.	9 W.	Holloman 3	Richfield
Long Beach Petroleum Co., Ltd.	28	3 S.	9 W.	Holloman 4	Richfield
Ed F. Sharkey	27	3 S.	9 W.	Peters 1	Richfield
The St. Helens Petroleum Co., Ltd.	28	3 S.	9 W.	Brown 1	Richfield
S. A. Guiberson, Jr.	16	5 S.	11 W.	1	
SAN DIEGO COUNTY:					
E. A. Edmonds, trustee				Edmonds 1	
SAN LUIS OBISPO COUNTY:					
Atascadero Oil Co.	27	26 S.	13 E.	Paso Robles Structure 1	
SANTA BARBARA COUNTY:					
Golconda Petroleum Corp.	9	8 N.	32 W.	Shaw 7	Cat Canyon
Golconda Petroleum Corp.	9	8 N.	32 W.	Shaw 8	Cat Canyon
Golconda Petroleum Corp.	9	8 N.	32 W.	Tognazzini 2	Cat Canyon
Golconda Petroleum Corp.	9	8 N.	32 W.	Tognazzini 4	Cat Canyon
Barnsdall Oil Co.	15	4 N.	29 W.	Doty 8	Elwood
Honolulu Oil Corp., Ltd.	15	4 N.	29 W.	90–6	Elwood
Pacific Western Oil Co.	16	4 N.	29 W.	92–11	Elwood
Caroline C. Spalding	16	4 N.	29 W.	Blue Goose 93 8	Elwood
Fred Cole	28	4 N.	27 W.	C. B. W. 1	Mesa
Frank E. Golder	28	4 N.	27 W.	Kavarno 1	Mesa
SUTTER COUNTY:					
The Buttes Oilfields, Inc.	35	16 N.	1 E.	3	
The Buttes Oilfields, Inc.	35	16 N.	1 E.	4	
The Buttes Oilfields, Inc.	36	16 N.	1 E.	5	
The Buttes Oilfields, Inc.	31	16 N.	2 E.	6	
TULARE COUNTY:					
Dil-Harp Oil Co., Ltd.	25	24 S.	26 E.	Dil-Harp 1-A	
VENTURA COUNTY:					
Bardeen Petroleum Co., Ltd.	13	4 N.	19 W.	4-B	Piru
Bardeen Petroleum Co., Ltd.	13	4 N.	19 W.	5-B	Piru
Bardeen Petroleum Co., Ltd.	13	4 N.	19 W.	6-B	Piru
Bardeen Petroleum Co., Ltd.	13	4 N.	19 W.	7-B	Piru
William A. Kirk	1	4 N.	20 W.	13	Sespe
Oak Mountain Oil Co.	6	4 N.	19 W.	12	Sespe
Associated Oil Co.	25	3 N.	23 W.	V. L. & W. 22	Ventura
Associated Oil Co.	26	3 N.	23 W.	V. L. & W. 27	Ventura
Shell Oil Co.	28	3 N.	23 W.	Taylor 77	Ventura
Shell Oil Co.	29	3 N.	23 W.	Taylor 79	Ventura
Shell Oil Co.	30	3 N.	23 W.	Taylor 78	Ventura
Shell Oil Co.	30	3 N.	23 W.	Taylor 80	Ventura
Shell Oil Co.	30	3 N.	23 W.	Taylor 81	Ventura
Henry Renshaw Dabney	20	2 N.	18 W.	G-1	

SPECIAL ARTICLES

Detailed technical reports on special subjects, the result of research work or extended field investigations, will continue to be issued as separate bulletins by the Bureau, as has been the custom in the past.

Shorter and less elaborate technical papers and articles by members of the staff and others are published in each number of CALIFORNIA JOURNAL OF MINES AND GEOLOGY.

These special articles cover a wide range of subjects both of historical and current interest; descriptions of new processes, or metallurgical and industrial plants, new mineral occurrences, and interesting geological formations, as well as articles intended to supply practical and timely information on the problems of the prospector and miner, such as the text of the new laws and official regulations and notices affecting the mineral industry.

LIMESTONE DEPOSITS OF THE SAN FRANCISCO REGION

By EDWIN C. ECKEL[1]

INTRODUCTION

The following paper covers the commercial limestone deposits of the San Francisco region, using that term to embrace the region between Santa Cruz and New Almaden on the south and Suisan-Napa-Tomales Bay on the north. The area includes the counties of Santa Cruz, Santa Clara, San Mateo, Marin and Solano, and most of the region except Alameda and Contra Costa Counties from which supplies of cement material, fluxing stone and other industrial limestones would normally be expected to supply the San Francisco Bay markets. In making this last statement it must be taken into account that, for purposes requiring special chemical grades, shipments from more distant limestone fields are a normal part of the San Francisco supply, while under certain market and price conditions, finished limestone products, such as cement, also enter the San Francisco markets from more distant mills.

Most of the field work on which this paper is based was carried on during 1931 and 1932 for the U. S. Treasury Department, as preparation for an income tax case in which raw material valuations were involved. That case is now concluded, and as many of the data and analyses are of broad public interest they are given publication in the present form. At certain points in the report the writer has added data from other sources in order to complete the discussion.

Credit is due the Treasury Department for supporting the field work, and the U. S. Bureau of Standards for making ten of the analyses. The writer is also indebted to Mr. W. H. George for analyses kindly made at the laboratory of the Cowell Portland Cement Company,

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[1] Consulting Geologist, 1503 Decatur Street, Washington, D. C.

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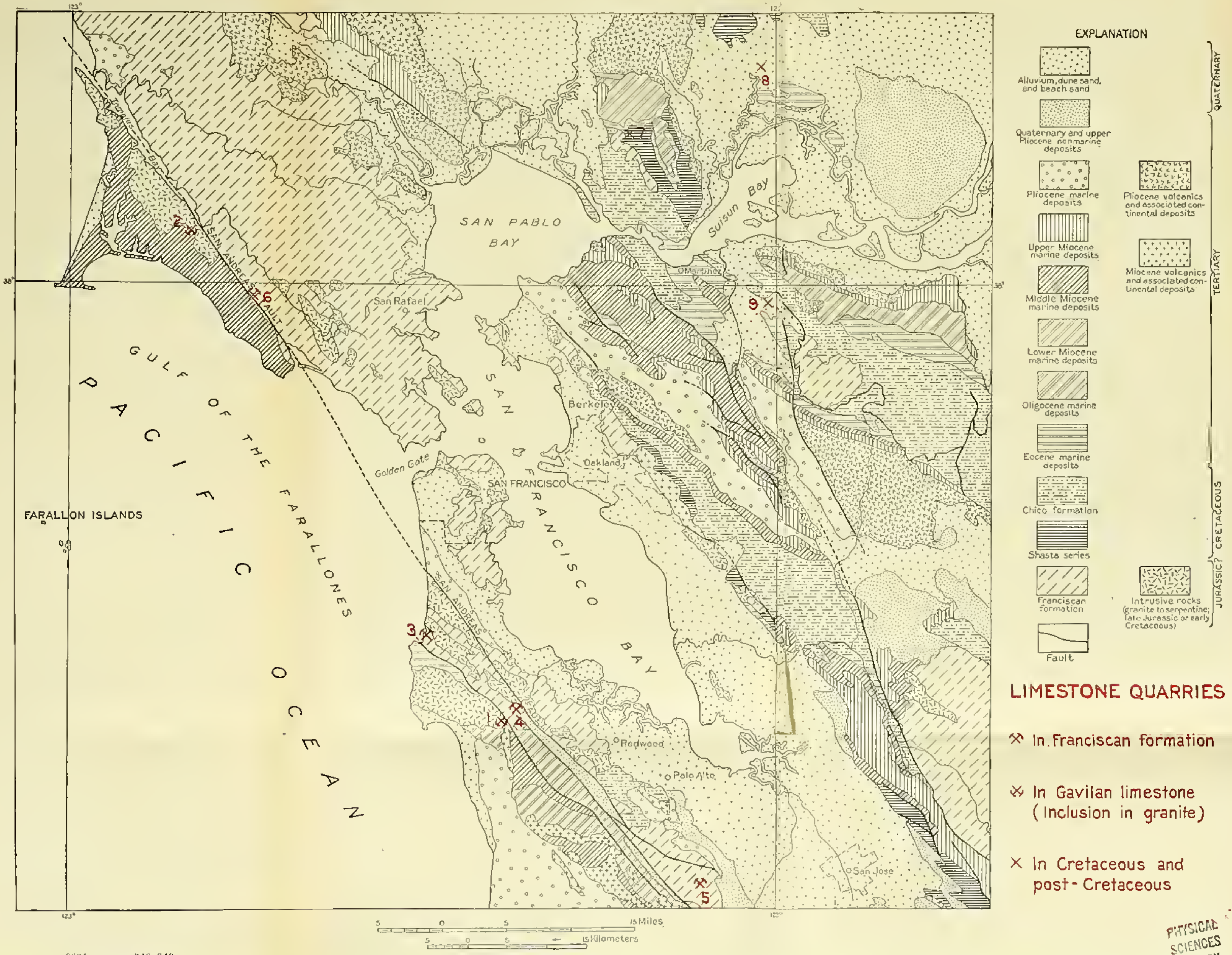
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EXPLANATION
Alluvium, dune sand, and beach sand
Quaternary and upper Pliocene nonmarine deposits
Pliocene marine deposits
Pliocene volcanics and associated continental deposits
Upper Miocene marine deposits
Miocene volcanics and associated continental deposits
Middle Miocene marine deposits
Lower Miocene marine deposits
Oligocene marine deposits
Eocene marine deposits
Chico formation
Shasta series
Franciscan formation
Intrusive rocks (granite to serpentine; late Jurassic or early Cretaceous)
Fault
QUATERNARY
TERTIARY
CRETACEOUS
JURASSIC?
LIMESTONE QUARRIES
In Franciscan formation
In Gavilan limestone (Inclusion in granite)
In Cretaceous and post-Cretaceous
SAN PABLO BAY
Suisun Bay
Martinez
San Rafael
Berkeley
Oakland
SAN FRANCISCO
Golden Gate
SAN FRANCISCO BAY
Redwood
Palo Alto
San Jose
GULF OF THE FARALLONES
PACIFIC OCEAN
FARALLON ISLANDS
SAN ANDREAS FAULT
SAN ANDREAS
Tomales Bay
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5 0 5 15 Kilometers

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and for supplying other preexisting analyses. To the officials of the Santa Cruz Portland Cement Company, in particular Messrs. Gay and Kinzie, the writer wishes to express his appreciation for courtesies extended. The work of Mrs. Junea Kelly, carried on entirely at private expense, has resulted in such a complete discussion of the question of limestone weathering and residuals that it is published as a separate paper.

Within the San Francisco region there are two especially important limestone formations, each capable of yielding large tonnages of good industrial stone. Besides these, there are several other limestone formations of less importance and promise which are from time to time brought to public attention. In this paper these different formations are discussed, beginning with the oldest of the geologic series:

I. A series of highly crystalline limestones, associated with quartz-schists and intruded by granites and diorites, occurs in the Paleozoic (?) rocks of California. The sedimentary portion of this series has been called the Santa Lucia series; the limestone formation of the series is best known as the Gavilan limestone.

II. In the Franciscan series, which is commonly considered as possibly of Jurassic age, there are limestone beds at least in one horizon. In their type locality, these limestones have been mapped and named by Lawson [2] as the Calera limestone.

III. In later periods, ranging from Cretaceous through Tertiary to Recent, limestone deposits of one sort or another have been formed, and some of these are of sufficient size and quality to supply commercial stone. The limestones here roughly grouped as Cretaceous-Pleistocene limestones range in character from normally bedded limestones to travertines, and to relatively recent deposits of shell.

I. THE GAVILAN LIMESTONES (PALEOZOIC?)

At intervals along the Californian coast, from San Luis Obispo County north to the Marin coast, there are areas of crystalline limestone and quartz-schist which are in places quite extensive. This group of rocks is known as the Santa Lucia series [3] and the limestone formation included in it, the Gavilan limestone. Both limestone and schist represent metamorphosed sediments; but, as they contain no fossils, proof of their age is lacking, and the series has only been tentatively ascribed as being most probably pre-Jurassic, and quite possibly Paleozoic. The fact that the Gavilan limestone is predominantly if not exclusively nonmagnesian would be, to a geologist specializing in rock compositions, the strongest evidence of its Paleozoic age.

Intrusive into the Santa Lucia series and therefore younger than it are enormous masses and dikes of acidic igneous rocks, chiefly granite and quartz diorite known collectively as the Montara granite. In this discussion the chief interest in these intrusive igneous masses lies in the fact that they limit the areas of the Gavilan limestone to tracts relatively small as compared to their original extent. That is, the Gavilan areas may now represent less than one-tenth of their original size, before the granites were injected.

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[2] Lawson, A. C., U. S. Geol. Survey Geol. Atlas, San Francisco folio (no. 193), 1914.

[3] Trask, however, applies the name Sur series to this group of rocks within the Point Sur quadrangle because the name Santa Lucia was first used by Lawson for the granite exposed near Carmel. (Note by O. P. J.)

Trask, P. D., Geology of Point Sur quadrangle, California: California Univ. Dept. Geology Bull., vol. 16, p. 133, 1926.

Lawson, A. C., Geology of Carmelo Bay: California Univ. Dept. Geology Bull., vol. 1, p. 9, 1893.

Santa Cruz County

Of the three counties in the San Francisco region in which the Gavilan limestone is exposed, Santa Cruz County leads in probable tonnages and actual development. The area covers the southern third of the county, from Santa Cruz city north to Felton, and northwest to near Davenport. Within this triangle, some 25 square miles in extent, there are at least 12 separate areas of Gavilan limestone. These represent portions of the same beds, now separated by intrusions of the Montara granite and by well-exposed quartz schists, known in this region as the Bonnie Doon schists.

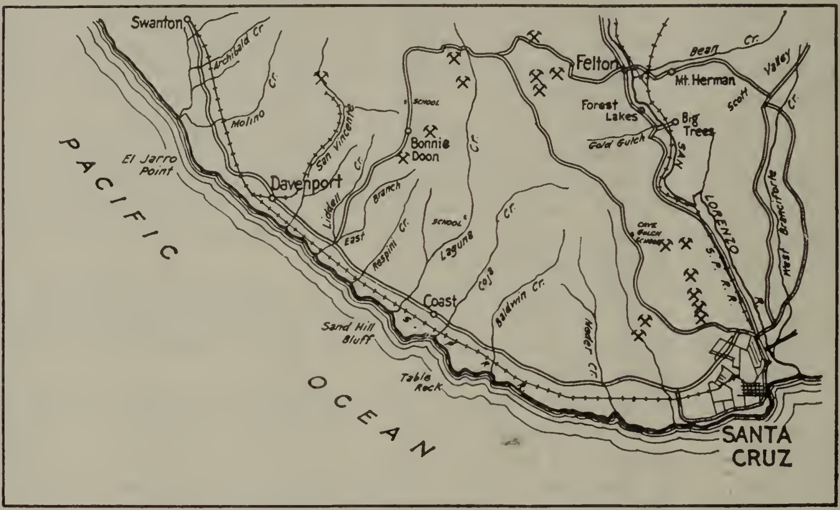
Swanton
Archibald Cr.
Cr.
Molino
El Jarro Point
PACIFIC
Davenport
San Vicente
Liddell Cr.
Branch
East
Respini Cr.
School
Bonnie Doon
School
Cr.
Laguna
Coast
Sand Hill Bluff
Table Rock
OCEAN
Cr.
Baldwin Cr.
Cr.
Felton
Forest Lakes
Gold Gulch
Mt. Herman
Big Trees
Bean Cr.
Valley
Scott
Cr.
San Lorenzo
S.P.R.R.
West Branch
Cave Gulch School
SANTA CRUZ

FIG. 1. Sketch map showing limestone quarries of Santa Cruz County.

The Gavilan limestone areas vary greatly in size. The largest known (located near the Cowell Home Ranch) is some 200 acres in extent. Some of the other areas show 10 to 40 acres of limestone exposed on the surface. The total acreage of Gavilan limestone exposed in Santa Cruz County is estimated by the writer as being between 600 and 700 acres.

The Gavilan limestone is typically a very coarsely crystalline marble, white to light blue in color, with practically no chert or other impurities except occasional patches of mica and other silicate minerals found particularly near igneous contacts. The rock is normally very low in magnesia, again excepting the margins near igneous contacts, where apparently contact metamorphism has taken place.

The bedding planes of the Gavilan limestone are often difficult or impossible to recognize. By taking advantage of the weathering of strata differing slightly in composition, however, the structure of the beds can be determined. The limestone is thus found to lie in a series of folds, in some places rather low but in other places steeply inclined, overturned and compressed. The writer's estimate of the true thickness of the limestone ranges between 300 and 600 feet, but it is entirely possible that the thickness may exceed the latter figure.

In making tonnage estimates the true thickness is not a matter of much importance, because the beds are usually so inclined that the working limits are fixed by depths rather than by true thickness. On that basis it is estimated that workings may extend to depths from 150 feet to 300 feet before ground water level is reached. Since the present annual draft on these large reserves does not amount, even in boom years, to over half a million tons, there is ample room for expansion in development whenever market conditions for stone, lime, and cement will justify it.

Within this area there are 17 limestone quarries, 10 of which are operative during normal business years. These quarries supply stone chiefly for the Santa Cruz Portland Cement Company at Davenport, the Cowell Lime Company near Rincon, the Holmes Lime Company near Felton, and the Pacific Limestone Products Company at Santa Cruz. In addition to supplying these more normal and steady demands, the quarries supply lesser quantities of limestone for flux, chemical purposes, agricultural stone and various minor uses.

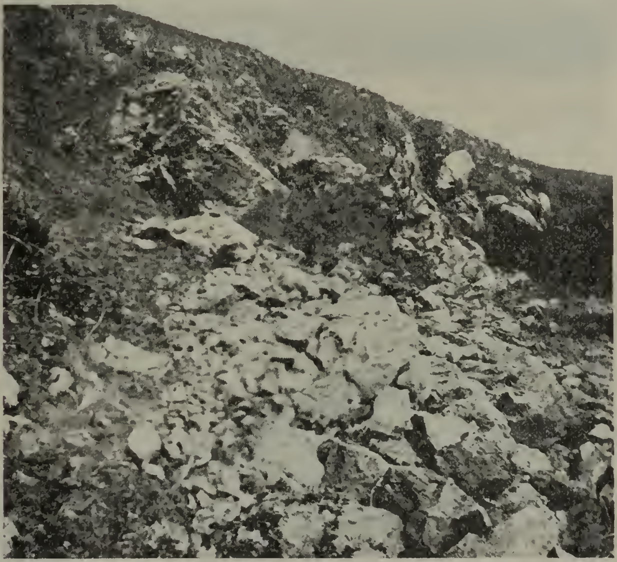

FIG. 2. Gavilan limestone outcrops west of Point Reyes station, Marin County.

San Mateo County

An isolated deposit of limestone is shown on the San Francisco Folio of the U. S. Geological Survey, located two miles west of Crystal Springs Dam, on the west side of Pilarcitos Creek, covering an area about one-half mile long and less than one-eighth mile wide. It was not visited by the writer, but it may be assumed to cover about 20 acres. Even that small acreage, however, might easily represent ten million tons or more of merchantable stone, but the location is not as favorable as the more readily accessible limestone deposits described under Santa Cruz and Marin counties.

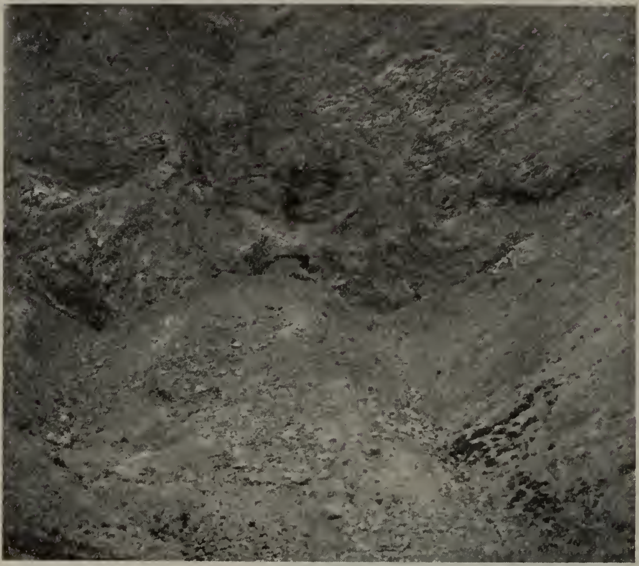

Fig. 3. Contact of chert (above) and limestone (below) in syncline of Franciscan series at Calera Hill.

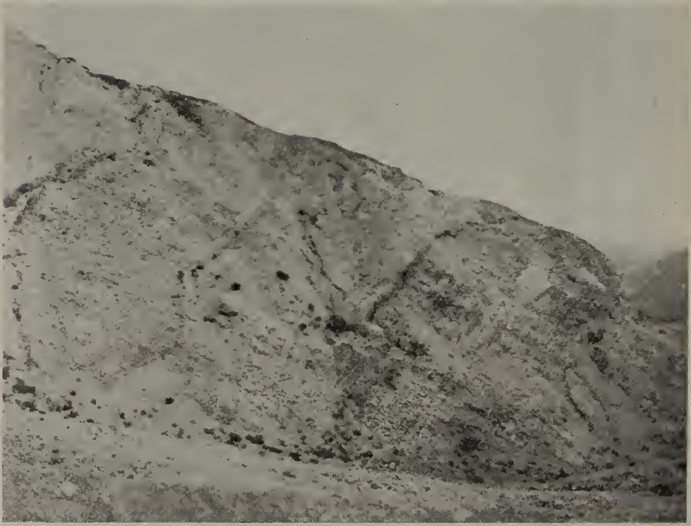

Fig. 4. Thin-bedded pure limestones of Franciscan series in Calera quarry.

Marin County

In Marin County the Gavilan limestone outcrops at the head of Tomales Bay in an area about one mile in length from south to north, by one-half mile in width. The limestone is cut off by the Montara granite on east and north. On the southwest side, however, the limestone is overlapped by Miocene shales, where it is quite possible that a greater extension of the limestone may be found under this cover. The area of limestone now exposed is between 300 and 400 acres.

This limestone area lies about one-half mile west of Tomales Bay, and extends as a surface outcrop from the latitude of Point Reyes Station to a point back of Trout Farm. The rock has been quarried at several points for lime-burning use, but judging from the timber growth, the last work must have been done 30 years or more ago. The geology of the area has been described by F. M. Anderson,[4] and there seems to have been done a good deal of desultory prospecting and test-pitting from time to time, notably on the Lockhart tract, where attractive outcrops permit easy sampling and the making of tonnage estimates, though there is no reason to suppose that other adjoining properties might not contain equal or even greater tonnages of limestone.

The limestone beds throughout the area dip steeply, and in various places show a vertical range of 300 feet or more. The field is, without question, very attractive from many standpoints.

Composition of the Gavilan Limestones

As previously stated, the Gavilan limestone is as a rule exceptionally low in magnesia and in cherty impurities. It does, however, normally carry a total of around 4 per cent to 6 per cent of silica, iron oxide, alumina and magnesium carbonate, thus leaving a lime carbonate content ranging around 95 per cent.

In the following table are assembled a number of reliable analyses made recently of the Gavilan limestone, as sampled from quarries and natural exposures at various points in Santa Cruz and Marin counties.

TABLE I. ANALYSES OF PALEOZOIC (?) LIMESTONES, SAN FRANCISCO REGION

No.	Silica (SiO_2)	Alumina (Al_2O_3)	Iron oxide (Fe_2O_3)	Lime carbonate ($Ca\,CO_3$)	Lime (CaO)	Magnesium carbonate ($MgCO_3$)	Magnesia (MgO)	Carbon dioxide (CO_2)
1	0.52	0.28	0.22	95.87	54.06	2.81	1.34	43.66
2	1.28	0.31	0.31	94.95	53.38	2.90	1.38	43.30
3	0.50	0.21	0.19	95.54	54.09	2.77	1.32	43.46
4	0.22	0.22	0.22	97.09	55.00	1.68	0.80	43.60
5	0.54	0.22	0.26	97.61	54.90	1.13	0.54	43.54
6	1.28	0.04	0.54	94.00	n. d.	2.93	n. d.	n. d.
7	1.66	0.44	0.20	96.60	n. d.	0.75	n. d.	n. d.
8	2.26	0.55	0.25	95.48	n. d.	1.10	n. d.	n. d.
9	2.3	0.76	incl.	96.0	53.8	n. d.	0.35	42.7
10	1.3	0.3	incl.	97.0	54.32	n. d.	1.25	42.68

Analysis 1. Bonnie Doon quarry, Santa Cruz County.
Analyses 2-5. Cowell quarries, near Felton, Santa Cruz County.
Analysis 6. Bonnie Doon quarry, Santa Cruz County.
Analysis 7. Old quarry near Trout Farm, Marin County.
Analysis 8, 9. Lockhart tract, near Inverness Park, Marin County.
Analysis 10. Near Inverness Park, Marin County.
Numbers 1-5, sampled by E. C. Eckel; analysed by H. R. Brandenburg (Cowell P. C. Co.).
Numbers 6-8, sampled and analysed by C. A. Newhall.
Number 9, sampled by E. C. Eckel; analysed by U. S. Bureau of Standards.
Number 10, sampled and analysed by F. Huber.

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[4] Anderson, F. M., The geology of Point Reyes Peninsula: California Univ. Dept. Geology Bull., vol. 2, pp. 119–153, 1899.

II. THE FRANCISCAN (JURASSIC?) LIMESTONES

The mass of the Franciscan rocks are of highly siliceous types (cherts, shales, sandstones), but at a few horizons in the series are beds of limestone. These are the subject of the following discussion and will be described in geographic order by counties.

San Mateo County

On the shore at Calera or Rockaway Beach, not far south of San Francisco, there is a strongly marked elevation—Calera Hill—made up entirely of beds of chert and limestone. The limestone reaches the shore, where there is a little natural bridge and cave. On the inshore side of the hill are the remains of old workings—glory-hole, tunnel, and some kilns. One quarter of a mile away the limestone reappears where there is an old working, together with the remains of crusher foundations and loading platforms. Trending southeast, for ten miles or so, limestone outcrops on the surface at intervals. At the other end of this belt are two quarries near the Crystal Lake dam, also operated in the past, and in one case recently, on the continuation of the same beds of limestone.

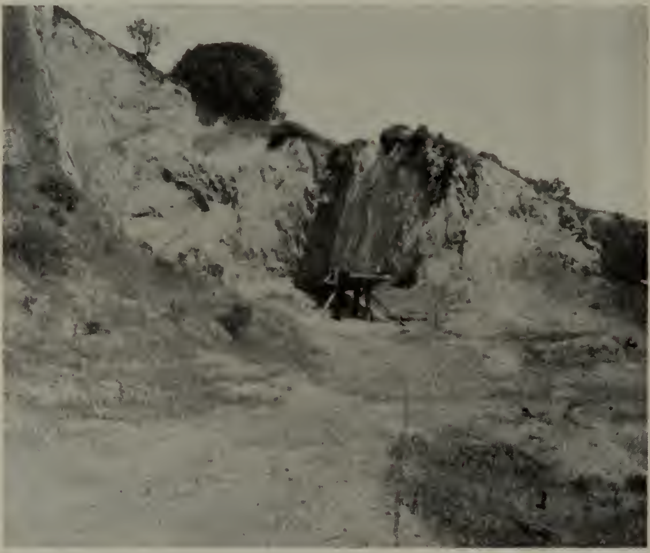

FIG. 5. Limestone (Franciscan) beds at Crystal Springs Lake quarry.

The limestone beds exposed in the belt just described are mapped by Lawson[5] in the San Francisco Folio, as the Calera limestone, which is considered as occurring interbedded with the Cahill sandstone formation of the Franciscan series. The limestones of Santa Clara and Marin counties are also Franciscan in age, and occupy somewhat the same position in that series as the Calera limestone, though it is impossible to establish the exact interrelations of the various beds. The term Calera limestone, therefore, can not safely be extended to cover these more distant deposits, which are here referred to merely as Franciscan limestones.

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[5] Lawson, A. C., U. S. Geol. Survey Geol. Atlas, San Francisco folio (no. 193), 1914.

In San Mateo County the Calera limestone is associated with thick beds of chert, and even in the limestone itself there is considerable flint or chert, in part interbedded, but in larger part probably representing later infiltration and deposition of silica. It is difficult to make any general statement as regards the thickness of workable limestone in the county. At some points there appears to be 100 feet at least which could be quarried or mined and handled, at not too great cost, so as to be reasonably free from chert. At other localities there are certainly under 50 feet of good stone available. Throughout the whole field the limestone beds may average around 200 feet in total thickness, but this usually includes 50 feet or more of chert beds.

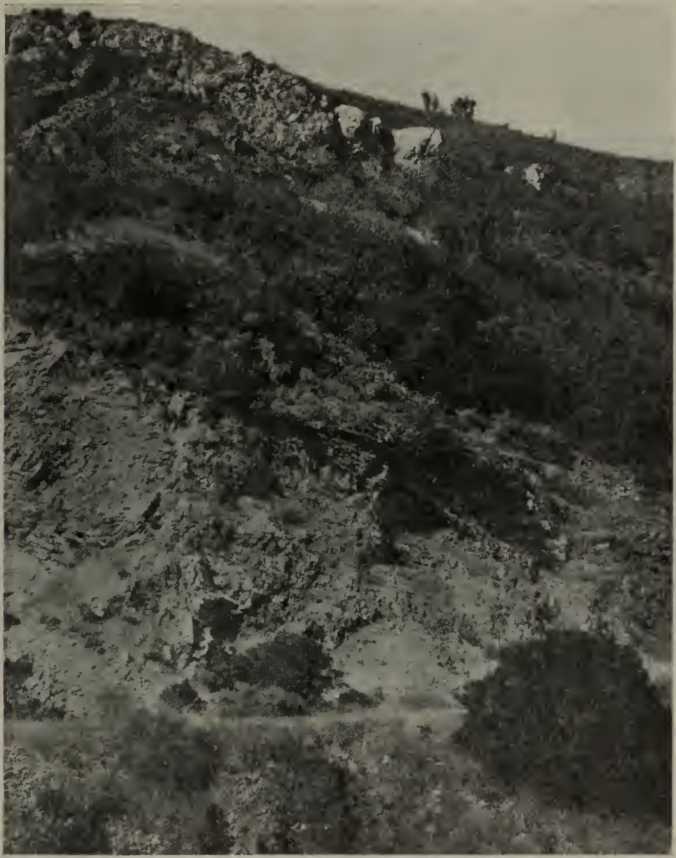

Fig. 6. Limestone on Sec. 18, T. 7 S., R. 2 W., M. D. M., on Permanente Creek, west of San Jose, Santa Clara County.

Photo by Walter W. Bradley.

Santa Clara County

Limestones of the Calera type are encountered both at the summit of Black Mountain and on its eastern slope,[5a] the latter having been worked rather extensively for use in the beet sugar industry. The quarry is located in Permanente Canyon about five miles west of Cupertino, Santa Clara County. The stone is interbedded with chert, but a high-grade material was produced after careful quarrying and hand-picking.

[5a] State Mineralogist's Report XVII, p. 185, 1920.

About ten miles southeast is another series of old workings on limestone of the same type, occurring in the Franciscan series, and possibly the exact equivalent of the Calera formation. These deposits are located in the region south of Los Gatos and San Jose, and have been opened at a number of rather widely-separated points, on at least two separate belts of limestone.

Of these workings, that of the old Guadalupe lime-kiln, located near the Guadalupe quicksilver mines, deserves note because it has been described in several published records. Extensions of the same limestone bed have also come to public attention more recently with a view to its use for a portland cement flotation. Another quarry, lying farther north, contains limestone which is very cherty and seems to have been worked entirely for road-stone. A fourth deposit, which in some respects appears to be the most promising of the whole field, is located two miles east of Lyndon Switch; it shows, below its bedded-limestone outcrops, the largest mass of travertine which the writer recalls having seen.

Taking all these workings and outcrops into consideration, it is clear that the tonnages of Franciscan limestone which can be found in Santa Clara County are very large indeed. But it is far less clear that any large proportion of this total tonnage can be economically quarried or mined and cleaned of its associated chert so as to yield a merchantable stone or a satisfactory cement material. To determine this feature would require considerably more detailed work than was possible during the writer's investigation.

Marin County

Though most of Marin County is underlain by rocks of the Franciscan series, only one limestone in that series has ever been worked so far as the writer could determine. The work is now a matter of historic interest, since it dates back to the period of Russian occupation of that region. It may be noted, however, that the stone sampled there gave better results than Franciscan limestones show in most localities. The area lies several miles south of Olema, on the road to Bolinas, and is marked by three lime-kilns, in each of which large trees are now growing. The size of the trees would indicate that 50 or 75 years must have elapsed since the kilns were last in operation, thus placing the date of their final abandonment in 1875 or 1850. On more or less traditional evidence it may be assumed that they were first put into operation around 1825.

The limestone beds at the old Russian quarry are now covered by debris, except at one side which was apparently the footwall. The limestone is strikingly low in both silica and magnesia, and is consequently higher in lime carbonate than most of the Calera limestones in counties farther south. The entire exposure shows now only some 50 feet of workable thickness and perhaps 100 feet along the outcrop. The topography, however, suggests that the belt may run for several miles along the valley, and the thickness may be considerably in excess of that now visible. Altogether the region appears worth prospecting, should a demand for limestone in that region arise.

Composition of Franciscan Limestones

As can readily be seen from the analyses grouped in Table II, the Calera limestone of the Franciscan series is in reality a high-grade stone, exceptionally low in such impurities as magnesia, iron oxide and alumina. Although it is customary to speak of argillaceous limestones as occurring in this portion of the series, that seems to be entirely in error. What does occur, and that frequently, is a highly siliceous limestone, the silica being due entirely to the presence of included masses or layers of chert. Analyses Nos. 5 and 11 of Table II give examples of this type of stone from widely separated localities; analyses 1, 4 and 8 are of a less cherty type; while the remaining analyses of Table II represent average Franciscan limestones at about their workable best grade.

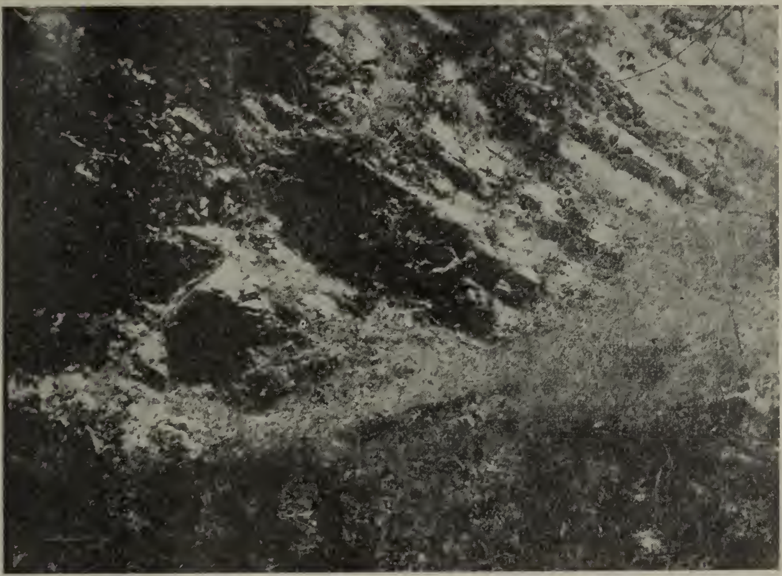

FIG. 7. Franciscan limestone beds in old quarry at Russian kilns, Marin County.

The entire question of commercial utilization of these Franciscan limestones depends, upon this matter of contained chert, not merely upon the amount of silica present in that form, but upon the way in which it is distributed in the limestone beds. For this reason each individual tract upon which it is proposed to quarry the Calera limestone should require special study and prospecting; it is impossible to take for granted that the conditions found in one set of outcrops will be the same (so far as working conditions are concerned) as those occurring a mile away. There are always beds of high-grade limestone in the Calera formation, but the question always is how much chert must be handled, to produce a ton of this high-grade merchantable stone.

Available Tonnages of Franciscan Limestones

In estimating the tonnages of Franciscan limestone that are available in this region, we must differentiate sharply between the total amount existing in the ground, and that part which can be considered available for industrial use.

Assuming that limestone beds as thick as those of the Franciscan could be economically mined or quarried to a depth of 1000 feet below the outcrops—and this would be entirely feasible if the bed were otherwise satisfactory—it is probable that in the counties of Santa Clara, San Mateo and Marin there are well over 1,000,000,000 tons of limestone in the Calera zone. On the other hand if we consider only that fraction of the total tonnage, so located as to be extractable at normal cost, and so low in chert as to be cleanable at no abnormal expense, we can not safely estimate the tonnage of available industrial stone at more than possibly 100,000,000 tons. The difference between these two estimates would represent the deposits where the chert cover is heavy, or where the chert layers in the limestone itself are too frequent or too intimately mixed with the good rock to justify profitable operation.

Estimates of available tonnage will differ widely, of course, according to the particular uses under consideration. For fluxing stone or chemical uses there are rigid limitations on silica, iron and alumina. For portland cement, on the other hand, these three constituents can reach very high percentages provided that they are properly balanced. But, except for the high-speed portland cements, a limestone very high in silica and low in alumina and iron has very little utility.

TABLE II. ANALYSES OF FRANCISCAN LIMESTONES, SAN FRANCISCO REGION

No.	Silica (SiO_2)	Alumina (Al_2O_3)	Iron oxide (Fe_2O_3)	Lime carbonate ($Ca\ CO_3$)	Lime (CaO)	Magnesium carbonate ($MgCO_3$)	Magnesia (MgO)	Carbon dioxide (CO_2)
1	4.5	0.49	incl.	94.2	52.8	n. d.	0.13	41.9
2	1.5	0.41	incl.	97.3	54.5	n. d.	0.25	43.0
3	2.9	0.94	incl.	95.3	53.4	n. d.	0.23	42.4
4	6.1	0.44	incl.	92.8	52.0	n. d.	0.22	41.1
5	12.3	0.79	incl.	86.6	48.5	n. d.	tr.	38.3
6	1.3	0.60	incl.	97.6	54.7	n. d.	tr.	43.2
7	1.1	0.68	incl.	97.8	54.8	n. d.	tr.	43.2
8	3.86	0.30	0.50	93.83	n. d.	1.04	n. d.	n. d.
9	1.90	0.76	0.20	96.74	n. d.	0.33	n. d.	n. d.
10	0.88	0.49	incl.	96.8	54.22	n. d.	1.76	42.54
11	10.05	1.25	1.05	86.6	48.5	n. d.	1.05	38.31
12	1.56	0.47	0.22	97.2		0.43		

Analyses 1, 10, 11. Quarry at Calera, San Mateo County.
Analysis 2. Old quarry near Crystal Springs Lake, San Mateo County.
Analyses 3 and 8. Guadalupe lime kiln quarry, Santa Clara County.
Analysis 4. Costello tract, near Guadalupe.
Analysis 5. Road metal quarry near Eagles, Santa Clara County.
Analysis 6. Old quarry east of Lyndon switch, Santa Clara County.
Analyses 7 and 9. Russian lime kilns, south of Olema, Marin County.
Analysis 12. Southwest flank of Black Mountain, Santa Clara County. This was taken from XVII Annual Report of the State Mineralogist, p. 185, 1920. California State Mining Bureau.
Numbers 1-6, sampled by E. C. Eckel; analysed by U. S. Bureau of Standards.
Number 7, sampled by Junea Kelly; analysed by U. S. Bureau of Standards.
Numbers 8 and 9, sampled and analysed by C. A. Newhall.
Numbers 10 and 11, sampled and analysed by F. Huber.
Number 12, sampled by W. W. Bradley; analysed by Sidney A. Tibbetts. This was taken from XVII Annual Report of the State Mineralogist, p. 185, 1920. California State Mining Bureau. This also contains Manganese oxide (Mn_3O_4) 0.05% and Phosphoric oxide (P_2O_5), 0.06%.

III. CRETACEOUS, TERTIARY, AND RECENT LIMESTONES

Most of the limestones in the later geological periods, are of little promise for future use, and are so localized as to be of slight general interest. They include various bedded limestones of Cretaceous and Tertiary age, travertines and other limy surface deposits of Pleistocene to Recent age, and shell beds which are being continuously deposited today.

At various horizons in the Cretaceous and Tertiary of the San Francisco region there are limestone beds of workable thickness and often of good grade. Some of these have been operated for one use or another, notably those south of Napa Junction, which were opened some years ago by the Standard Portland Cement Company and later abandoned. Similar deposits occur elsewhere in the bay region, and some of these bedded limestones are sufficiently thick and extensive to give promise of moderately large tonnages. There are none, so far as the writer knows, whose tonnages can be estimated as high as many of the Gavilan and Franciscan limestone areas, but there are doubtless a number of Cretaceous and later deposits which might range up to 5,000,000 tons.

Next in the geologic series are the travertines, surface deposits of usually very pure nonmagnesian limestone, formed by the leaching out of lime carbonate from preexisting beds of limestone, and the subsequent redeposition on the ground surface. Deposits of this type have long been worked for Portland cement and other uses, notably by the Pacific Portland Cement Company near Suisun in Solano County, and by the Cowell Portland Cement Company near Concord in Contra Costa County. The former quarry is now abandoned as a cement-material producer, but the deposit still yields small outputs of high-grade stone for other purposes. The Cowell quarries are still producing raw material for the cement plant nearby. Aside from these worked travertine areas, large travertine deposits exist unworked at many points in the San Francisco region; the largest noted are those near Lyndon, Santa Clara County, where the bed ranges up to 30 feet in thickness, and the deposits fringing the Gavilan limestone outcrops in southern Santa Cruz County. All of these may come into use later for one purpose or other.

Finally, in following geologic history up to recent days, we reach the shell beds which are still forming on the California coasts. In both San Francisco and Tomales Bays there are heavy deposits, ranging well into the tens of millions of tons, of oyster, clam and other marine and brackish-water shells. These beds were in some cases started many thousands of years ago, as determined by careful study of the material assembled at the Indian shell mounds of the region. The accumulation of the shells has, under favorable conditions, continued to the present day; and as stated above in some localities the total available tonnage is very large. Such beds in the vicinity of Redwood City constitute the source of raw material for the cement plant of the Pacific Portland Cement Company. Accurate analyses of shell for industrial purposes are not common, and for that reason the writer has inserted in the table below a group of very carefully sampled and analysed results from the unpublished work of Mr. Newhall.

TABLE III. ANALYSES OF CRETACEOUS, TERTIARY, AND LATER LIMESTONES

No.	Silica (SiO_2)	Alumina (Al_2O_3)	Iron oxide (Fe_2O_3)	Lime carbonate ($Ca CO_3$)	Lime (CaO)	Magnesium carbonate ($MgCO_3$)	Magnesia (MgO)	Carbon dioxide (CO_2)
1	4.7	1.7	incl.	91.8	41.1	n. d.	0.58	41.1
2	1.08	0.93	0.07	93.34	n. d.	1.76	n. d.	n. d.
3	0.09	0.17	0.38	94.01	n. d.	0.23	n. d.	n. d.
4	0.20	0.00	0.16	95.68	n. d.	tr.	n. d.	n. d.
5	0.56	0.31	0.19	95.34	n. d.	tr.	n. d.	n. d.
6	0.00	0.16	0.18	96.69	n. d.	tr.	n. d.	n d.
7	1.16	0.78	0.14	92.57	n. d.	tr.	n. d.	n. d.
8	1.55	0.99	0.49	95.74	n. d.	0.79	n. d.	n. d.
9	1.4	0.92	incl.	95.7	53.6	n. d.	0.76	43.2

Analysis 1. Cretaceous limestone near Napa Junction. Sampled by E. C. Eckel. Analysed by U. S. Bureau of Standards.

Analyses 2, 3, and 4. Fresh clean recent shells—clam, oyster, mussel. Sampled and analysed by C. A. Newhall.

Analyses 5, 6, and 7. Average, high and low on ten samples of old shell from marine beds. Sampled and analysed by C. A. Newhall.

Analysis 8. Travertine, near Suisun, Solano County. Sampled and analysed by C. A. Newhall.

Analysis 9. Travertine near Cowell schoolhouse. Sampled by E. C. Eckel. Analysed by U. S. Bureau of Standards

Composition and Tonnages

The analyses presented of the Cretaceous limestones are of the upper pure beds of that deposit, while samples from the lower two-thirds of it would show rock grading down into a very clayey limestone, fit only for cement use. The travertine analyses are fair samples of good travertines; deposits worked close to the former ground surface would show far more impurities, while the travertines from the Franciscan series are often badly intermixed with residual chert. The shell analyses are excellent samples covering the normal range of such shell deposits, as found on the Atlantic, Gulf and Pacific coasts; when secured by dredging this relatively pure shell is mixed with a good deal of silt and sand.

The tonnage estimates of this Group III are far less definite than those of the stone reserves of Groups I and II. The recent shell deposits of the region, both large and small, might possibly produce 100,000,000 tons; while the travertines and other limestones of the group, taken together, could hardly be counted on for half that amount. In this respect the geologic periods from the Cretaceous to Recent, inclusive, are scantily supplied with limestone as compared with either those of the Gavilan or Franciscan. The geologic basis for this difference does not need discussion here.

IV. THE PROBABILITIES OF FUTURE DEVELOPMENT

The future possibilities of limestone development in the San Francisco region, depends not only on the probable total tonnages available, but the probable future demand. We can assume that in the three classes of limestone described above, the available tonnages estimated total something over one thousand million tons. In no year to date has as much as one million tons ever been drawn from this supply. The output has supported three Portland cement plants, at most times two rather large lime plants, and at various shorter periods has contributed small tonnages to other uses. At one time or another some forty limestone quarries have been opened in this region, of which not over ten have operated within the past five years.

With return to normal business and industrial growth of the San Francisco market area, which seems more firmly founded than that of most other American regions, we may expect to see not only reopening of old quarries but the opening of new ones and the construction of new mills to use their outputs.

A period of comparatively low prices is one in which the buyer is more critical in his specifications; he demands better quality for his dollar. In the future, therefore, there will be larger differences in value between poor and good quarries, and common- and high-grade stone, and this situation should be borne in mind in any plans for future quarry development.

The future is likely, therefore, to bring about stricter insistence both on quarry economies and on grades of quarry products. In the San Francisco region practically all of the limestones discussed in this report could be used for making cement, but for industries and uses requiring higher-grade stone the supply is not so ample. The limestones of the Gavilan type could probably be quarried so as to yield a product carrying 95% lime carbonate; and that with care in avoiding impurities it might be shipped on a guarantee of 97% or in some cases 98%. This implies, however, that more care should be employed in quarrying in order to reduce the ultimate cost; and so far as the writer knows there is no formation in the San Francisco region—or indeed in California—which could safely guarantee less than one per cent insoluble, as is done in the Michigan Limestone Company quarries or the Baker quarries in West Virginia. Shell can not be easily cleaned to yield much over 95%; on higher specifications it too would be costly. Furthermore, the limestones of the Franciscan series, are rarely capable of giving a merchantable product even approaching this degree of purity.

If, therefore, increasing demands for limestone are to be met from local supplies, the undeveloped and large resources of the Gavilan formation would be available to meet the greater part of the new demand so far as the cement, lime, and chemical industries are concerned. The Franciscan series, on the other hand, would supply the cheapest and best material for crushed stone of the whole region because it breaks readily and in the use of this product there is no particular objection to the presence of chert.

LIMESTONE WEATHERING AND PLANT ASSOCIATIONS OF THE SAN FRANCISCO REGION

By Junea W. Kelly[6]

INTRODUCTION

The following paper represents a portion of a more extended study of the effects of regional geology upon plant and animal life, as influenced by topography and soils, both residual and transported. The field work was carried on during 1932. The study has been purely a matter of private research, and subject to limitations of time and expense, but it is hoped that further results, covering broader fields, will be published in the near future. Since this report is intended as a supplement to the preceding paper it is purposely limited to the limestones of the coast region near San Francisco, including the Gavilan and Franciscan limestone formations of Santa Cruz, Santa Clara, San Mateo and Marin counties.

MECHANICAL DISINTEGRATION OF LIMESTONES

Like all other rocks, limestones are subject to destruction through the purely physical or mechanical effects of running or falling water, winds, waves, and frost. In moist climates, however, chemical effects of solution are sometimes so great as completely to conceal the products of mechanical disintegration. It is only in extreme cases of arid climate or in regions along seacoasts that we see destruction of limestone masses on a large scale by purely mechanical causes, with little or no aid from chemical solution.

The San Francisco region offers several good examples of the mechanical destruction of limestone along the seacoast, just as the Mojave Desert and other arid regions in the south show us mechanical weathering of the limestone resulting in the form of talus and shingle. Perhaps the clearest instance in all California of purely coastal effects on limestone is shown at Calera Hill, near Rockaway in San Mateo County. Here the sea winds and sand blasts clear the seaward face of the limestone hill of much of the protective plant cover, and leave the outcrops exposed to mechanical destruction.

The rocks of Calera Hill are composed of interbedded cherts and limestones of the Franciscan series. A view of the hill, shows it projecting above the surrounding Pleistocene sand and silt flats. A cross section of the hill, from southwest to northeast, shows that it is an eroded syncline. The compressed rocks in this structural trough apparently resisted weathering more than did the stretched rocks in the bordering anticlines which are now completely destroyed by erosion.

The hill has been extensively quarried, but the original ground surface still remains on both its flanks. On the seaward flank there is little or no soil or plant life, and practically no trace of chemical solution. The slope is formed of angular fragments, from a few inches thick to small grains of broken chert and limestone. This mechanical residual material might have yielded soil high in lime, if disintegration had been allowed to continue, but the finer material is constantly being swept away by the winds on the upper levels and by the waves along the base, so that except in protected crevices and pockets there is never accumulated sufficient fine residue to give a roothold for vegetation.

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[6] Lecturer for the University of California Extension.

Emphasis has been laid upon this local example, because writers of ecologic and related literature in many cases use the term 'calcareous soil' to cover any soil derived from weathering or dissolving of limestone, disregarding the fact that the end results of the two processes are absolutely different. Mechanical disintegration of a limestone yields a residue which is full of lime carbonate, and is therefore a 'calcareous soil,' while chemical solution, a far commoner mode of limestone weathering, ends by yielding a soil practically free from lime in any form. If the term 'calcareous soil' is to retain any real meaning at all, it must be limited to soils high in lime, and not merely to the soils which happen to lie on limestones. This initial confusion in usage leads to serious errors when plants are described as preferring or avoiding calcareous soils, merely because they happen to be found on or away from a limestone region.

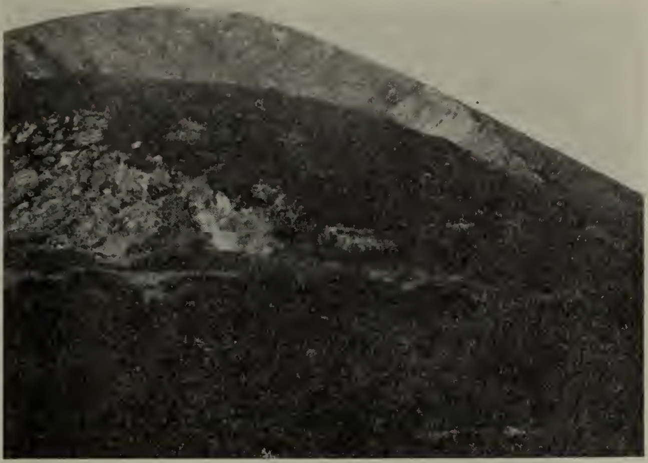

FIG. 1. Calera Hill, San Mateo County. Franciscan limestones and cherts projecting above Pleistocene level.

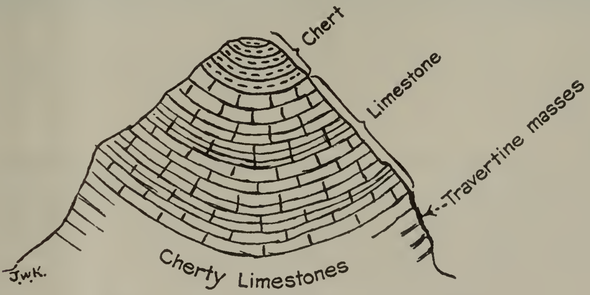

FIG. 2. Cross-section of Calera Hill.

There are some limestones so granular and porous that they are capable of supporting vegetable growth with little or no preliminary weathering of the rock. The chalk of Europe is one case, and the result is that all English ecologic literature, based on local knowledge of this one limestone, tend to speak of limestone soils as supporting luxuriant plant growth, and as being very porous. So far as Californian limestones are concerned, neither of these generalizations can be applied. The limestones in this region are in general too highly metamorphosed to be very porous or to give much foothold for vegetation when the rock is still in unweathered condition.

CHEMICAL SOLUTION OF LIMESTONES

Limestones differ from all other rocks in the extreme facility with which they are dissolved by even weak acids. The effects of solution producing decay differ sharply from the effects of mechanical disintegration, both as regards resultant soils, and plant associations. Instead of shingle-covered hills and terraces, chemical solution normally produces valleys, sinks and caves; instead of a coarse residual soil, composed of chert and limestone fragments, solution in the end produces a deep clayey residual soil, almost free from lime; and instead of a mass of rock fragments normally supporting only few plants, solution gives deep soils on which certain plants grow freely.

The ruling factor in the chemical decomposition of limestones is that lime carbonate is very soluble in water carrying even small amounts of very weak acids. Ground water, passing downward through limestone beds, steadily removes and transports quantities of lime carbonate by solution, redepositing it elsewhere, possibly as a surface travertine or as a new limestone bed in some lake or ocean. In regions where rainfall is abundant, and the average temperature warm or hot, this process ultimately leaches out practically all the lime carbonate, and most of the magnesium carbonate, from the original limestone bed, leaving behind the relatively insoluble impurities, such as chert, flint, clayey or siliceous minerals. A typical 'limestone soil' resulting from chemical decay is therefore composed chiefly, not of limy matter, but of fragments of chert or flint and masses of red clays or iron oxides. Such 'limestone residuals,' formed under tropical conditions, extend in depth for many or even for several hundreds of feet. In the southeastern United States extensive areas show this type of soil decay due to solution.

Another feature of limestone solution, most striking where the beds are steeply inclined, is selective weathering. The purest and most porous of the limestone beds are first and most completely attacked, leaving adjacent more highly siliceous strata less effected. In the early stages of the weathering process the outcrop is therefore likely to be made up of alternating bands; one bed may be deeply decayed while another, more resistant and flinty, may stand out sharply in relief. Such alternation of clayey pockets and hard layers gives good roothold and living conditions for certain types of plant.

In the San Francisco region there are few long-continuous belts or brood areas of limestone, therefore solution effects rarely have striking topographic results. The location and form of the hills and valleys are apparently governed by other factors. On examination of any limestone outcrop area, however, we can see the local effects of chemical solution more or less clearly displayed, according to the character and the attitude of the limestone beds involved. In the Crystal Springs Lake quarry the Franciscan limestones have been attacked selectively, certain beds having been dissolved rather completely to considerable depths, leaving behind a residue of very siliceous (cherty) clay; while more resistant beds adjacent show little effects from solution.

The inter-relation between such solution-soils and certain plant species is, in some parts of the United States, very striking and definite. Brown,[7] for example, notes that the White Cedar *(Thuja occidentalis)* inhabits limestone regions and, still more specifically, that the Red Cedar *(Juniperus virginiana)* thrives on limestone soils and outcrops. C. W. Hayes, discussing the great limestone valleys of east Tennessee and north Georgia called attention to the fact that in those valleys the 'cedar hills,' which are covered thickly by the Red or Virginia cedar, are always areas where the nonmagnesian Chickamauga limestone outcrops, while the parallel and closely adjacent ridges of the magnesian Knox dolomite are barren of those trees. Eugene Smith,[8] discussing the extensive Cretaceous chalk prairies of central Alabama and Mississippi has noted, as an example of soil avoidance, that the Long-Leaf Pine *(Pinus palustris)* of that region never appears directly on the chalk soils, but inhabits only the areas in which the chalk has been covered by the sands and gravels of the Lafayette (Pleistocene) formation.

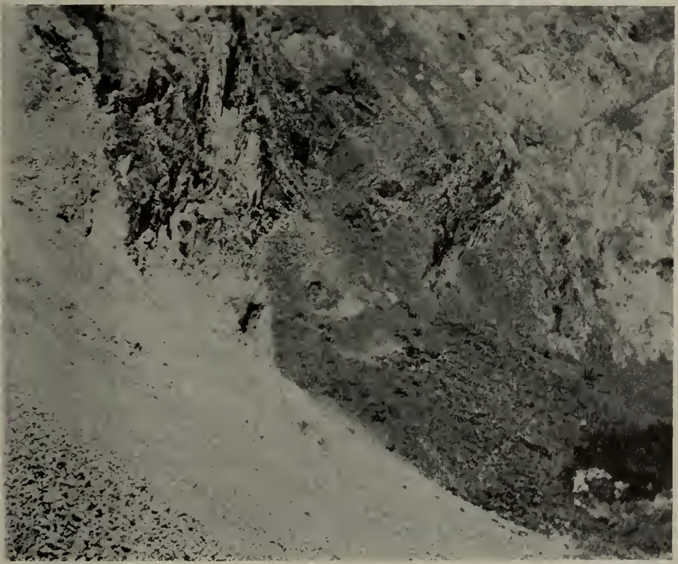

FIG. 3. Crystal Springs Lake quarry. Light colored limestone beds in left of picture are unweathered; the dark areas in center and right are deeply decomposed by solution.

In the San Francisco region such close correlation between limestone soils and coniferous species is as yet less clearly established, but certain facts suggest that there may be rather close inter-relations in some instances. Four species, restricted to the Coast Range *(Pinus muricata, Pinus radiata, Cupressus goveniana* and *Cupressus macrocarpa)* occur in the region, yet none have been found on limestone areas. In Marin County, the Bishop Pine occur on the residual soils of both the Miocene shale and Montara granite, but stops short just before the Gavilan limestone is reached. This is particularly noticeable on the Lockhart tract west of Point Reyes station, for here the Bishop Pine reaches to within a few feet of the contact between the sandy shales of the Miocene and the outcrops of the limestone. Sudworth[9] has noted that *Pinus contorta,* a species widely distributed through the Coast Ranges, avoids limestone.

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[7] Brown, H. P., Trees of New York State, Native and Naturalized. New York State College of Forestry, Tech. Pub. No. 15, 433 pp., 1921, Syracuse, N. Y.

[8] Smith, E. A., Portland Cement Materials, U. S. Geol. Survey Bull. 243, pp. 71–84, 206–219, 1905.

In an area like the San Francisco region, however, there is a modifying factor to be taken into account because of the long season of summer drought. Such hills as Lockharts, Black Mountain, and others where limestones outcrop, become very dry and can only with difficulty support any vegetation. At Bonnie Doon, in Santa Cruz County, on the other hand, the exposed area of Gavilan limestone shows the usual rather luxuriant redwood association of that locality, but this is due to greater winter precipitation, for the slope faces westward and receives moisture from the heavy summer fogs.

PLANT SOLUTION OF LIMESTONES

Plants, both living and dead, exercise influences on the decomposition of rocks in two ways, first by mechanical disintegration of the rock, second by producing effective chemical solutions. Vegetation aids, therefore, in both the modes of weathering that have already been discussed, but it adds certain features of its own to both types.

Mechanical disintegration is effected chiefly by the higher forms of plants, through the agency of expanding roots and stems. With granites and other massive rocks the roots in joint planes, while in sedimentary rocks the roots commonly insert themselves between bedding planes, which, in the case of limestones, are often already weakened or enlarged by solution. One excellent example of root action may be seen in the Russian kilns south of Olema, where roots of a Douglas 'spruce' *(Pseudotsuga taxifolia)* have torn apart the mortar-laid walls on one of the battery of lime-kilns.

Chemical solution, effected by plants, is often seen in limestones in the form of pits and channels along the lines of plant roots. The lower forms of plants, such as the lichens, are among the first organisms to appear on rocks. They are able to grow on practically any rock whose surface endures long enough for them to get a foothold. In humid regions where limestones are dissolved rapidly by heavy rainfall lichens do not play an important role, but in areas approaching aridity, like the San Francisco region, lichens assist materially in the weathering of hard limestones. Some lichens excrete an acidic juice beneath their developing reproduction bodies, and as limestones are readily attacked by organic acid, small pits are dissolved out in which the apothecia (fruiting-body) lies. In some cases the hyphae (thread-like extensions) of *Verrucaria marmorea* are known to have penetrated to a depth of two centimeters (over $\frac{3}{4}$ of an inch) into the limestone on which the lichen was growing.

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[9] Sudworth, George B. Forest trees of the Pacific Slope, U. S. Dept. of Agriculture, Forest Service, 1908, p. 53.

On Black Mountain in the Santa Cruz Range, at an elevation of 2700 feet the writer found *Rinodina bischoffi immersa* and *Verrucaria calciseda fuscaspora* forming tiny solution pits in the Franciscan limestone where it is exposed at the summit of the mountain. (*Rinodina* forms bluish or gray spots on the limestone while *Verrucaria* appears as white spots). In the same locality the writer found *zahlbrucknera calcarea* forming black stains on the limestone which was in place, while *Lecidea decipiens* was found growing on earth, probably a limestone residual soil, in crevices of the limestones.

In addition to these species, Herre[10] records three others: *Lecidea globifera,* a lichen of calcareous soil collected in Stevens Creek Canyon; *Leptogium plicatile,* found on limestone near the summit of Black Mountain; and *Placynthium nigrum,* occurring at New Almaden. This last form, although rare in this region, ranges widely and is commonly found on calcareous rocks. In all the localities cited the species occur on limestones of the Franciscan series. It seems entirely probable that the greater purity and solubility of the highly crystalline Gavilan limestones permit such free solution that lichen colonization becomes difficult.

While some lichen species are specifically or at least predominantly calciphile (lime-preferring), others seem indifferent to the composition of the rock on which they grow, and are found on many types of rock. At Calera and in other quarries the writer found *Buellia albo-atra saxicola,* a species of wide range in habitat, growing abundantly and forming white patches on the grayish limestones. There are some lichens which occupy indifferently a variety of soil or rock environments, but require that calcium carbonate be available in the material on which they grow. This preference among the lower plant forms is especially interesting in view of the fact that there is so much diversity of opinion among botanists and ecologists as to the calciphile and calcifuge (lime-avoiding) plants of the higher orders.

SUMMARY

In regions of warm climates and abundant rainfall, limestones weather chiefly by chemical solution. This process results in the formation of a deep mantle of residual soil, which is normally high in silica, alumina and iron oxide, but low in lime.

In arid or in coastal regions, limestones weather chiefly by mechanical disintegration. This process results in the formation of a thin mantle of rock fragments, and finally (under favorable conditions) in a residual soil high in both silica and lime carbonate.

The soil-types produced by these two distinct modes of weathering should be clearly distinguished. Studies of natural plant associations suggest that in many cases the lower plant forms, such as lichens, are definite indicators of the calcareous composition of soils. It is also suggested that careful areal work may show special associations in the case of higher plant forms in accordance to these different types of soil. Existing literature, however, must be carefully scrutinized and checked by geologic work in order to remove confusion as regards the characteristics of the two types of soil, formed by the weathering of limestones, each of which supports an individual environment.

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[10] Herre, Albert W. The Lichen Flora of the Santa Cruz Peninsula. Washington Acad. Sci. Proc. vol. 12, pp. 27–269, May 1910.

BOOMING

By C. McK. Laizure

Booming is defined as ''the accumulation and sudden discharge of a quantity of water (in placer mining where water is scarce).'' In Great Britain the term 'Hushing' is used for a similar operation to denote the discovery of veins by the accumulation and sudden discharge of water, which washes away the surface soil and lays bare the bedrock. In California the contrivances for collecting and discharging water are termed 'self-shooters,' an idea suggested by the sudden and violent manner in which the water makes its escape. The discharge gate is also known to many as a 'boomer' or 'flop-gate.' This gate closes a reservoir until it is filled with water, when it automatically opens and allows the water to flow into the sluices. When the reservoir is empty, the gate closes, and the operation is repeated at regular intervals.

Booming may be briefly described as ground sluicing on a grand scale. It has been used as one method of placer mining in California since the 'days of 49,' but is evidently of much greater antiquity as this system of water mining is mentioned by Pliny in his 'Natural History' (A. D. 77).

The process of booming has some advantages which should not be overlooked. Where there is only a small flow of water available and little working capital this method will often serve well and even when there is considerable water but only limited funds it makes a strong appeal to the miner. In some cases, even with plenty of capital available, it has proved the most feasible method of attack.

Booming in its operation resembles a cloudburst rushing down a ravine and it will accordingly wash out a large amount of material. Where there is top dirt or uncemented barren overburden to be moved it affords a cheap, quick and easy method of removing it.

Boericke[1] states ''An average-sized reservoir should be about 10 feet wide, 6 feet deep, and about 100 feet long. It will contain about 22,000 gallons of water when full. An instance is given of an area 900 feet long and 25 feet wide stripped of muck and gravel 5 feet thick in 3 weeks; the cost, including dam and gate, did not exceed 7 cents per cubic yard.''

At the Holland Mine, Trinity County, operated by Patrick Holland for more than 50 years, either alone or with a single helper, Holland used a self-shooter. His reservoir held 5 acre-feet and automatically discharged every half hour, giving a torrential flow for a short period to wash the gravel through the sluices. The gold was noticeably coarse at this property, many large nuggets being recovered.

A natural ground sluice may be used or regulation sluice boxes but the sluiceway should be wide for the rushing water and gravel as otherwise the ditch will be immediately choked up and fine gold will be carried off and lost. At best, like most large-scale hydraulicking, it is not an efficient method of recovering fine gold.

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[1] Boericke, Wm. F., Operating Small Gold Placers. John Wiley & Sons, Inc., New York.

It is thought that the burdensome efforts of individuals, small groups and associations with very limited capital to wrest a living by placer mining on a small scale may in many cases be lightened and their earnings increased by adopting the booming method of working surface gravels. To this end the following detailed description and cut of a 'self-shooter' or 'flop-gate' is here reprinted from the Mining & Scientific Press of March 17, 1917.

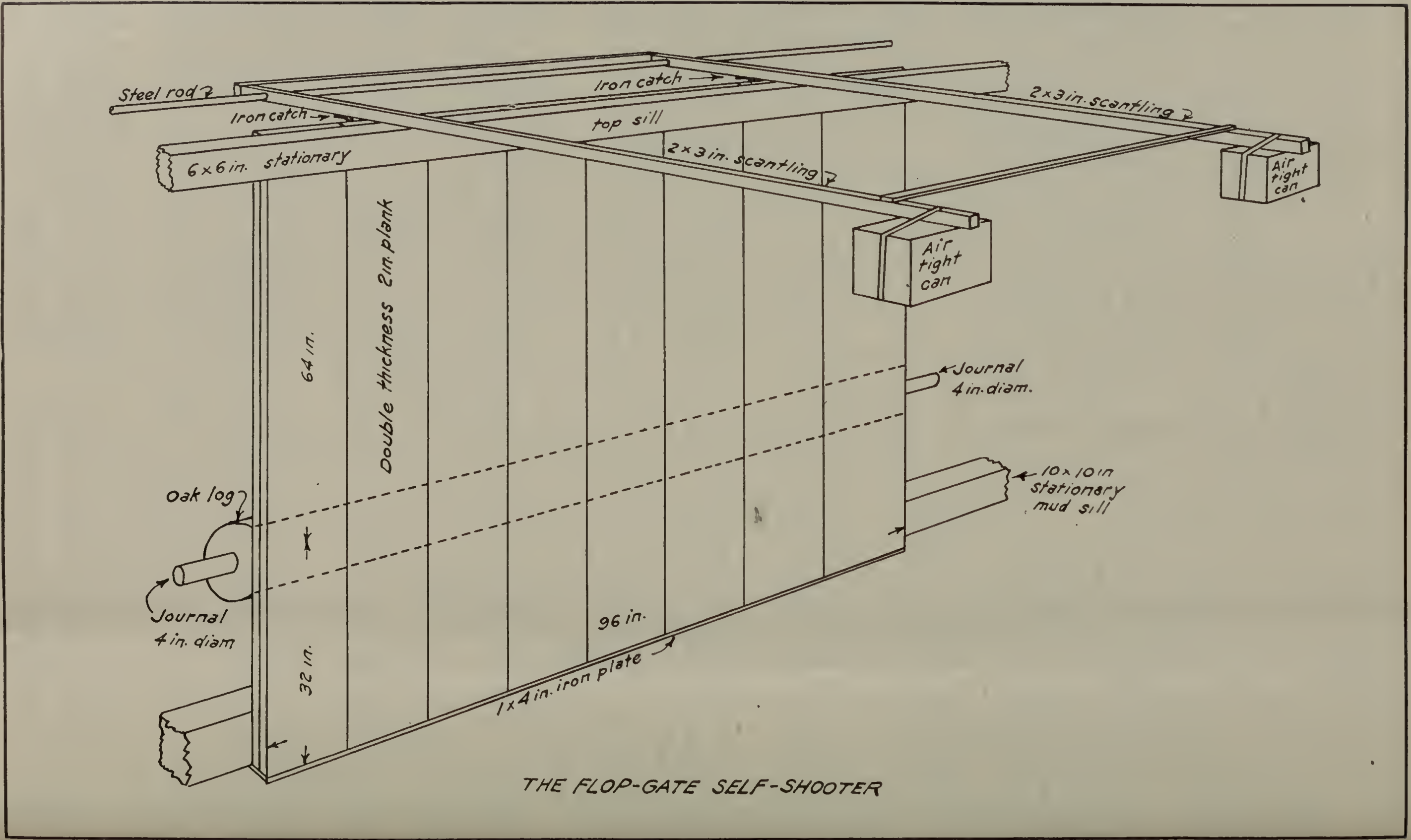
"The self-shooter, when properly constructed, needs little attention, and the frequency of discharge generally can be regulated to suit the convenience of the miners. The accompanying sketch (Fig. 1) shows the details of construction of a self-shooter used near Placerville, El Dorado County, California. The dam is solidly constructed of a crib of timbers filled with rock and earth, faced with plank and made water-tight. The gate only is shown in the sketch (Fig. 1), together with the stationary sill at the bottom, and another timber at the top, the function of which is apparent.

"The gate is made of 2-in. planks spiked together, and is provided with a heavy iron plate at the bottom, to overbalance the upper part, as shown. The horizontal axis of the gate is placed about one-third of the way from the bottom of the gate, and consists of a log of oak or other wood 16 in. diam., hewn to a 10-in. face on one side and solidly bolted to the planks. The bearings at the ends as shown are turned down in a lathe or shaved by hand, and these rest in boxes of either iron or wood that are bolted to the timbers on each side of the gate and between which it swings. These timbers have been omitted from the sketch in order to avoid confusion. It may be explained that an axis of wood is preferable to one of iron, as when made of metal it has been found to spring at the center under the pressure of the water, unless very heavy.

"When the gate is closed the water accumulates in the reservoir, gradually rising until nearly full. The gate is provided with two latches, as shown in the sketch, these being attached to a frame of scantling. Two air-tight cans are also fixed to this frame, as indicated. When the water reaches the level of the cans they lift the float-frame, thus releasing the latches, and the water in the reservoir flows out.

"As the axis of the gate is at a distance of one-third its height from the bottom, the greater pressure from the water is obviously on the upper two-thirds of its surface, which causes the gate to overturn, permitting the escape of the water. When the reservoir is nearly empty, the weight of the iron shoe at the bottom of the gate returns this to a vertical position, the latches automatically falling into place and holding the gate closed until the floats again operate. Thus the reservoir refills and the gate automatically discharges at approximately regular intervals. Usually two 5-gal. oil cans afford the necessary buoyancy to start the mechanism.

"In some self-shooters, a box is placed on the outer side of the dam into which a quantity of water overflows from the reservoir when it has reached a stated height, and the weight of the water in the box is utilized in opening the gate-latches. The principle is the same in either case. All that most miners require is an idea, as usually they


Steel rod
Iron catch
Iron catch
top sill
2×3 in. scantling
2×3 in. scantling
6×6 in. stationary
Air tight can
Air tight can
Double thickness 2 in. plank
64 in.
32 in.
96 in.
1×4 in. iron plate
Oak log
Journal 4 in. diam
Journal 4 in. diam.
10×10 in stationary mud sill

THE FLOP-GATE SELF-SHOOTER

FIG. 1.

have sufficient ingenuity to arrange a contrivance of this kind to suit their own fancy, and adapted to such materials as are at hand.''

Another scheme for automatically opening and closing a gate is one in which the gate is lifted straight up. To do this the gate is attached to one end of a suspended beam, which has a water-tight box with a flap valve in the bottom, attached to the other end. When the dam is full a part of the water overflowing passes into a launder which conducts the water to the box. This is made of such size that when it is full it will overbalance and lift the gate by its weight, as it descends. The contents of the reservoir is thus instantly released. After the box has fallen a certain predetermined distance the valve of the water box comes in contact with an upright post which opens it and allows the water in the box to run out. The empty box then rises as the heavier gate settles into place and again permits the reservoir to fill.

DEATH VALLEY NATIONAL MONUMENT—CALIFORNIA

By the President of the United States of America

A PROCLAMATION

WHEREAS, It appears that the public interest would be promoted by including certain lands known as Death Valley, in California, within a national monument for the preservation of the unusual features of scenic, scientific, and educational interest therein contained;

NOW, THEREFORE, I, HERBERT HOOVER, President of the United States of America, by virtue of the power in me vested by section 2 of the act of Congress entitled "An act for the preservation of American antiquities," approved June 8, 1906 (34 Stat. 225), do proclaim and establish the Death Valley National Monument and that, subject to all valid existing rights, the area indicated on the diagram hereto annexed and forming a part hereof be, and the same is hereby, included within the said national monument.

Warning is hereby expressly given to all unauthorized persons not to appropriate, injure, destroy, or remove any feature of this monument and not to locate or settle upon any of the lands thereof.

The Director of the National Park Service, under the direction of the Secretary of the Interior, shall have the supervision, management, and control of this monument as provided in the act of Congress entitled "An act to establish a National Park Service, and for other purposes," approved August 25, 1916 (39 Stat. 535-536), and acts additional thereto or amendatory thereof.

IN WITNESS WHEREOF, I have hereunto set my hand and caused the seal of the United States to be affixed.

Done at the City of Washington this 11th day of February, in the year of our Lord nineteen hundred and thirty-three, and of the Independence of the United States of America the one hundred and fifty-seventh.

HERBERT HOOVER.

By the President:

HENRY L. STIMSON, Secretary of State.

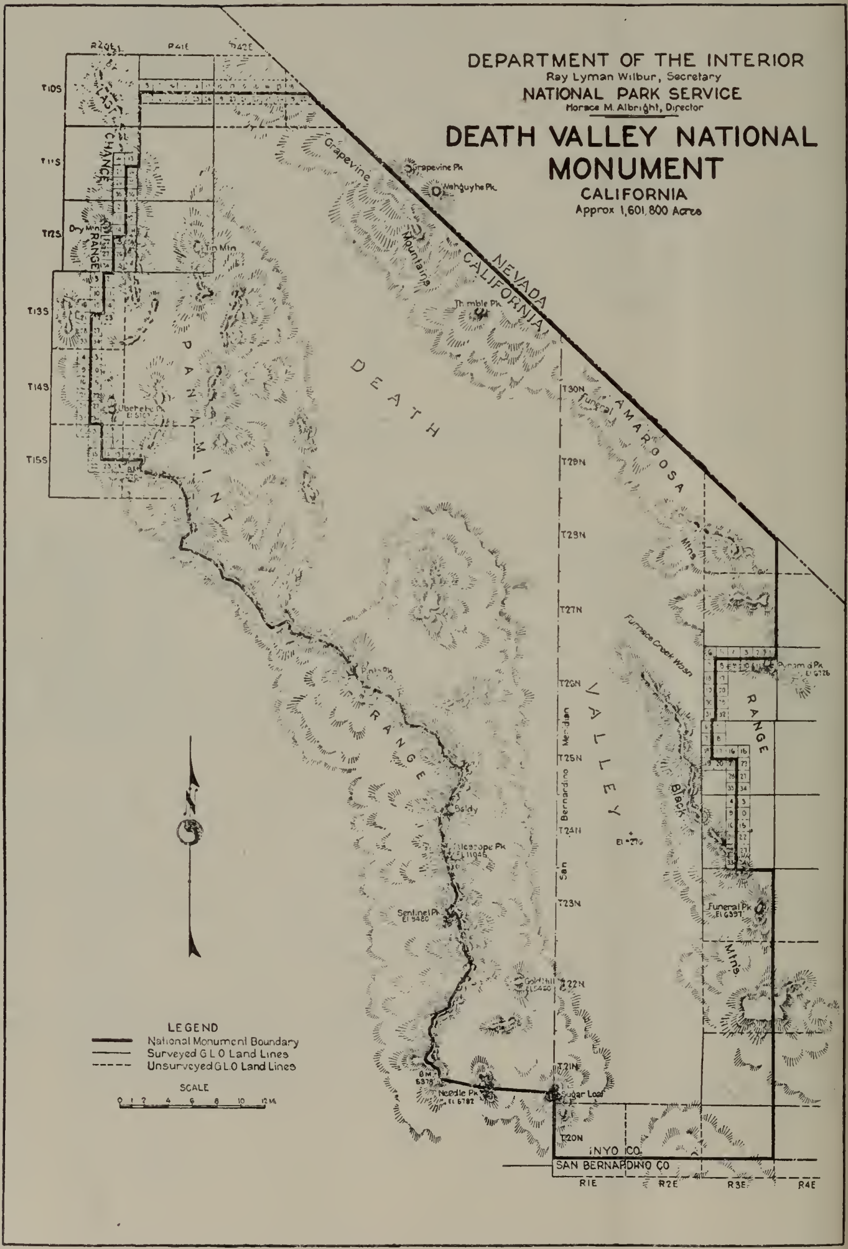

DEPARTMENT OF THE INTERIOR
Ray Lyman Wilbur, Secretary
NATIONAL PARK SERVICE
Horace M. Albright, Director
DEATH VALLEY NATIONAL MONUMENT
CALIFORNIA
Approx 1,601,800 Acres
NEVADA
CALIFORNIA
Grapevine Mountains
Grapevine Pk
Wahguyhe Pk
Thimble Pk
DEATH VALLEY
PANAMINT RANGE
LAST CHANCE RANGE
Dry Mtn
Tin Mtn
Ubehebe Pk
Funeral AMARGOSA Mtns
Furnace Creek Wash
Pyramid Pk
BLACK RANGE
Funeral Pk
Mtns
Telescope Pk
Sentinel Pk
Needle Pk
Sugar Loaf
San Bernardino Meridian
T10S
T11S
T12S
T13S
T14S
T15S
T30N
T29N
T28N
T27N
T26N
T25N
T24N
T23N
T22N
T21N
T20N
R40E
R41E
R42E
R1E
R2E
R3E
R4E
INYO CO.
SAN BERNARDINO CO.
N
LEGEND
National Monument Boundary
Surveyed G.L.O. Land Lines
Unsurveyed G.L.O. Land Lines
SCALE
0 1 2 4 6 8 10 12 Mi

FIG. 1.

NEW STATE LEGISLATION

Several bills affecting the mining industry were passed and approved by the Governor during the last session of the Legislature. Those of particular interest are Senate Bill No. 480, Assembly Bill No. 548 and Assembly Bill No. 1543. A résumé of these follows:

Placer Mining Districts

SENATE BILL NO. 480: An act to provide for the organization, operation, financing, government and dissolution of Placer Mining Districts.

Introduced by Senator Seawell.

Approved by the Governor June 12, Chapter 899, Statutes 1933.

Sections 3–58 prescribe method and procedure of filing petitions, holding hearings by county board of supervisors and calling of election, setting boundaries of districts.

Sections 59–67 relate to assessments, expenditure and other financial proceedings for districts.

Sections 68–72, meetings of board of directors.

Sections 73 and 74 follow:

''Sec. 73. Acting through such board, the district shall have power:

''73.1. To manage and conduct its business and affairs.

''73.2. To make and execute all necessary contracts.

''73.3. To employ and appoint such agents, officers, and employees as may be required, and to prescribe their duties.

''73.4. To enter upon any land and make surveys, locate the necessary works and the lines for canals, and the necessary branches for the same on any land which may be best for such location; lay out the necessary canals or other means of conducting tailings to storage basins or reservoirs and to lay out such storage basins or reservoirs.

''73.5. To acquire by purchase, lease, contract, condemnation, or other legal means, all lands, waters, water rights, and other property necessary for the construction, use, supply, maintenance, repair and improvement of such canals or other means used for the conduct of water and tailings and for the supply of water, and for such purpose to acquire and hold the stock of corporations, domestic or foreign, owning water, water rights, canals, water works, franchises, concessions or rights.

''73.6. To make and perform agreements with any government or governmental authority, political subdivision, public or municipal corporation, for the joint acquisition, construction, leasing, ownership, disposition, use, management, maintenance, repair or operation of any rights, works or other property of a kind which might lawfully be acquired or owned by a placer mining district.

''73.7. To acquire the right to store water in any basin or reservoir or to carry water through any canal, ditch or conduit not owned or controlled by the district.

"73.8. To grant to any owner or lessee of the right to the use of any water, the right to store such water in any reservoir of the district or to carry such water through any canal, ditch or conduit of the district.

"73.9 To exchange property or rights of the district for property or rights of any person, firm, corporation, district, or other public or municipal corporation, political subdivision, or the State.

"73.10. To make all agreements and do all acts necessary to make available to land in the district the facilities for placer mining operations and the storage of tailings therefrom.

"73.11. To construct dams, canals, ditches, or other means for the conducting of water and tailings from any property in the district to a storage basin.

"73.12. To make any agreements or conveyances, sue and be sued, and expend the moneys of the district for the purpose of the exercise of any of the powers granted by this act.

"73.13. To establish equitable by-laws, rules and regulations and to make charges for the distribution and use of water and the facilities of the district among the owners of the land. Such by-laws, rules and regulations must be printed in convenient form and distributed to such owners. To establish the general fund and any desirable or necessary special funds of the district, prescribe the keeping of accounts thereof and to require a report to the board of directors at such periods as the board may consider convenient of the finances of the district.

"Sec. 74. The use of all water or other facilities required for the working of the mines in the lands of any district formed under the provisions of this act, together with the facilities auxiliary thereto and all other property required in fully carrying out the provisions of this act is hereby declared to be a public use, subject to the regulation and control of the State in the manner prescribed by law."

Sections 75–96 refer to property matter, bonds, assessments, interest, contracts.

Sections 97–99, rights of way.

Sections 100–111, other legal phases, county treasurer to be treasurer of district, proceedings for dissolution of district.

Division of Mines Revolving Printing Fund

ASSEMBLY BILL NO. 548: Amends State Mining Bureau Act.

Introduced by Mr. Williamson.

Approved by the Governor June 5, Chapter 748, Statutes 1933.

Section 10 of said act is amended to read as follows:

Sec. 10. All moneys received by the State Mining Bureau (or State Division of Mines) or any officer thereof, from sales of publications issued by said bureau, shall be deposited at least once each month in the State treasury to the credit of a fund which is hereby created and designated "Division of Mines revolving printing fund." Said fund shall be used and is hereby appropriated for the use of said bureau in addition to such other funds as may be from time to time appropriated by the Legislature, for the printing and publishing of reports, bulletins, and maps issued by the said bureau. The State Controller is authorized to require financial reports from the State Mining Bureau or any officer thereof.

Navigable Waters

ASSEMBLY BILL NO. 1543: Amends section 2349 of the Political Code.

Introduced by Messrs. Scudder and Hornblower.

Approved by the Governor May 10, Chapter 276, Statutes 1933.

The part in which the mining industry is interested is the last paragraph which deals with the Klamath River.

Section 2349 is amended to read as follows:

2349. The following streams and waters are hereby declared navigable and to be public ways:

So much of a slough as lies between Simonds Canal in the town of Alviso and the bay of San Francisco;

All of the Coyote River between the bay of San Francisco and the place where the same is now crossed by the tracks of the Southern Pacific Railroad Company;

All of the slough known as the Alviso Slough, sometimes called Steamboat Slough, lying between the bay of San Francisco and the place where the same is now crossed by the tracks of the Southern Pacific Railroad Company;

All of the slough known as the Guadalupe Slough, and being the outlet or mouth of the Guadalupe River, lying between San Francisco Bay and its junction with Alviso Slough;

All of Devil's Slough lying within the corporate limits of the city of San Jose, or of the town of Sunnyvale in Santa Clara County, and extending thence to San Francisco Bay;

Petaluma River, from its mouth to the southerly line of Washington Street, in the city of Petaluma;

The Sonoma River, between its mouth and a point opposite Fowler's hotel in the town of San Luis;

The Napa River, between its mouth and a point sixty feet below the westerly line of Lawrence Street in the city of Napa;

The Suisun River, between its mouth and the town of Suisun embarcadero;

The Sacramento River, between its mouth and a point one hundred feet below Reid's Ferry, in Shasta County;

The Feather River, between its month and a point fifty feet below the bridge crossing Feather River first above the mouth of the Yuba River;

The Yuba River, between its mouth and a point at the mouth of the slough at the foot of F Street, in the city of Marysville;

The San Joaquin River, between its mouth and Sycamore Point;

The Stockton Slough, between its mouth and the west line of El Dorado Street in Stockton;

The Mokelumne River, between its mouth and the first falls;

The Tuolumne River, between its mouth and Dickinson's Ferry;

Deer Creek, between the house of Peter Lassen and its mouth;

Big River, three miles from its mouth; Noyo River, three miles from its mouth;

Albion River, three miles from its mouth;

San Antonio Creek, in the county of Alameda, from its mouth to the old embarcadero of San Antonio;

The Arroyo del Medo, in the county of Santa Clara, from its mouth to the upper line of the town of New Haven;

Mission Creek, in the county of San Francisco;

That portion of Channel Street, in the city of San Francisco, lying easterly of the northeasterly line of Seventh Street, the width thereof to be one hundred forty feet;

That certain creek running through the tideland survey numbered 68, and swamp and overflowed land survey numbered 145, from its mouth to the head of the tidewater therein;

Johnson's Creek from its mouth at San Francisco Bay to Simpson's Landing;

The north branch of Alameda Creek, from its mouth to Eden Landing;

San Rafael and Corte Madera creeks, in Marin County, from their mouths as far as tidewater flows therein;

The Neuces Creek, from its mouth at Suisun Bay to a point one-half mile above the warehouse of George P. Loucks;

Diablo Creek, from its junction with the Neuces, to a point opposite the warehouse of Frank Such, in Contra Costa County;

The Arroyo de San Antonio, or Keys Creek in Marin County, from its mouth at Tomales Bay to the warehouses on the point at Keys embarcadero;

All the streams and sloughs emptying into Eel River;

And all the streams and sloughs south of Eureka, in Humboldt County, which are now or at any time have been used for the purpose of floating logs or timber;

And all the sloughs south of Humboldt Point, in said county, that at high water mark have a depth of two feet of water, and wide enough to float and admit a boat carrying five tons or more freight;

Novato Creek, or estuary, in Marin County from its mouth to Sweetzer's Landing;

Salinas River and Elkhorn Slough, or Estero Viejo, in Monterey County, from its mouth as far up as tidewater flows;

First Napa Creek, Second Napa Creek, and Third Napa Creek, in Sonoma County, between Napa and Sonoma rivers;

Moro Cojo Slough, in Monterey County, from Salinas River to tidewater;

Galinas, or Guyanas Slough or creek, in Marin County, from its mouth to the line of the Sonoma and Marin Railroad;

Clear Lake, in Lake County; provided, that nothing herein contained shall be deemed to interfere with rights of owners and claimants of swamp or overflowed land around the margin of said Clear Lake to reclaim the same;

Newport Bay, in the county of Orange, and all arms thereof, the sloughs connecting therewith in which the tide ebbs and flows, including the former bed of the Santa Ana River from a point where said Santa Ana River formerly emptied into the said bay up to a line extending across the former bed of the Santa Ana River which line is the northeasterly extension of the northwesterly bank of "The Rialto" as "The Rialto" is shown upon a map of Canal Section, Newport Beach, and is recorded in book four, page ninety-eight of miscellaneous maps, records of Orange County, California;

The Klamath River from its mouth in Del Norte County to its confluence with the Shasta River in the county of Siskiyou; provided, that nothing herein shall abrogate or infringe existing mining rights or the rights of locating or operating mining claims thereon, otherwise than by being made subject to the public rights of way herein declared.

ADMINISTRATIVE

Walter W. Bradley, State Mineralogist

Personnel.

There have been no changes of personnel during the past three months to be noted.

Chapters of State Mineralogist's Report Combined.

As noted elsewhere herein under 'Special Articles,' at the recent session of the Legislature the Mining Bureau Act was amended (Sec. 10) and now provides that the moneys received from sales of this Division's publications shall be placed in a special fund designated 'Division of Mines Revolving Printing Fund' for use in printing reports, bulletins, and maps. This amendment became effective August 22, 1933. Owing to inadequacy of the budgetary printing allotment and the fact that this new revolving fund has not yet accumulated a sufficient balance, it became necessary to combine the July and October quarterly chapters in the form of this present issue.

New Publications.

'California Journal of Mines and Geology' (quarterly) January-April, 1933, being Chapters 1 and 2 (combined) of the State Mineralogist's Report XXIX; price 80 cents. Contains: 'Gold Deposits of the Redding and Weaverville Quadrangles'; 'Geologic Formations of the Weaverville-Redding Districts,' with Geologic Map; 'Economic Geology of Portions of Del Norte and Siskiyou Counties'; 'Applications of Geology to Civil Engineering'; 'The Lakes of California'; 'Suspension of Assessment Work'; 'Tracing Buried-River Channel Deposits by Geomagnetic Methods'; Statistical estimate of California's mineral production in 1932.

Commercial Mineral Notes, Nos. 118–126, inclusive, February-October, 1933, respectively. These 'notes' contain the lists of 'mineral deposits wanted,' and 'mineral deposits for sale,' issued in the form of a mimeographed sheet monthly. It is mailed free to those on the mailing list for "California Journal of Mines and Geology" and to others on payment of 15 cents postage paid in advance for the year. As an evidence of the interest in mines and mineral resources now showing considerable activity, this mimeographed 'sheet' has had to be expanded to two and three pages in recent months.

Mails and Files.

The Division of Mines maintains, in addition to its correspondence files and the library, a mine file which includes original reports on the various mines and mineral properties of all kinds in California.

During each quarterly period there are several thousand letters received and answered at the San Francisco office alone, covering almost every phase of prospecting, mining and developing mineral deposits, reduction problems, marketing of refined products, and mining law. In addition to this, hundreds of oral questions are answered daily, both at the main office and the district offices, for the many inquirers who come in for personal interviews and to consult the files and library.

MINERALS AND STATISTICS

Statistics, Museum, Laboratory

Harry H. Symons, Statistician and Curator

STATISTICS

Tabulations are presented herein showing the completed totals for all substances for the year 1932 grouped by substances and by counties. The complete, detailed annual report on the mineral production of California for 1932 will be available, as Bulletin No. 109 of the State Division of Mines and Mining.

Summary for 1932.

The total value of the mineral output of California for the year 1932 was $199,196,493, being a decrease of $16,767,927 from the total of 1931 of $215,964,420. There were fifty different mineral substances exclusive of a segregation of the various stones grouped under gems; and all but one of the fifty-eight counties of the State contributed to the list.

As revealed by the data following, the salient features of 1932 compared with the previous year were: Petroleum, gold, mineral water, and talc and soapstone were the major mineral products which showed an increase in the value of output during the year, while declines in values were registered by miscellaneous stone, cement, borax, brick and hollow building tile, soda, and natural gas. Petroleum showed an increase in value of $1,054,524 although there was a decrease from 188,310,605 barrels to 177,745,286 barrels. Prices received for the lighter gravity oils were higher than in 1931. Natural gas decreased from 344,959,920 M cu. ft. worth $16,690,695 to 284,168,872 M cu. ft. worth $16,272,061.

Of the metals the gold yield increased from a total value of $10,814,162 to $11,765,626. Decreases in value were registered by all the other metals, copper from 12,954,842 lbs. worth $1,178,890 to 1,417,536 lbs. worth $89,307; quicksilver from 13,478 flasks worth $1,121,624 to 5239 flasks worth $279;780; silver from 867,818 fine oz. worth $251,667 to 493,535 fine oz. worth $139,176; and lead from 3,934,240 lbs. worth $145,568 to 2,418,626 lbs. worth $72,480. A small mount of platinum was produced as a by-product from placer gold operations. There were increased activity in both placer and lode gold mining during the year and small scale placer operators, about 12,000 individuals, produced $493,437 of gold, compared with about $163,000 for 1931. The prices of the other metals were so low that it did not pay to mine them.

Of the structural materials, bituminous rock was the only one to show an increased output. Decreases were shown by cement from 7,693,712 bbls. worth $11,510,655 to 5,657,549 bbls. worth $7,967,107;

miscellaneous stone from a total value of $11,848,531 to $7,183,643; brick and hollow building tile from a total value of $2,560,415 to $1,605,086; and granite from $636,741 to $398,676.

Of the industrial materials, the total value decreased from $4,741,939 to $3,820,711. Increased values in annual production were shown by mineral water, and talc and soapstone, while all other minerals in this group showed a decreased value. The salines showed a decrease in total value from $11,779,513 to $6,135,440 with every material in the group falling off in production.

The distribution of the 1932 output of California by substance is shown in the following tabulation:

Substance	Amount	Value	Number of producers
Barytes	8,507 tons	$49,409	5
Bentonite (fuller's earth)	4,295 tons	57,670	6
Borax	179,356 tons	2,856,470	6
Brick and hollow building tile		1,605,086	53
Cement	5,657,549 bbls.	7,967,107	10
Clay (pottery)	167,284 tons	204,891	48
Coal	9,508 tons	36,468	4
Copper	1,417,536 lbs.	89,307	[e]2
Dolomite	35,275 tons	40,956	3
Feldspar	2,294 tons	15,988	3
Gems		4,961	9
Gold		11,765,726	[a]
Granite		398,676	20
Gypsum	46,867 tons	93,818	4
Lead	2,418,626 lbs.	72,480	[e]6
Lime	27,510 tons	254,223	25
Limestone	168,950 tons	487,788	
Marble (onyx and travertine)		42,505	5
Mineral water	19,031,224 gals.	1,495,988	42
Natural gas	284,168,872 M cu. ft.	16,272,061	[h]
Petroleum	177,745,286 bbls.	142,890,247	[h]
Platinum	336 ozs.	8,142	16
Pumice and volcanic ash	9,891 tons	86,034	12
Quicksilver	5,349 flasks	279,780	79
Salt	256,353 tons	918,480	10
Sandstone		13,286	8
Silica (sand and quartz)	33,997 tons	136,324	8
Silver	493,535 fine oz.	139,176	[f]
Soapstone and talc	10,690 tons	122,880	7
Soda	58,017 tons	826,369	3
Stone, miscellaneous[c]		7,183,643	242
Unapportioned[d]		2,780,554	[d]
Total value		$199,196,493	

[a] There were 720 lode mines and 88 placer mines, not including snipers, prospectors, and various individuals who sold small lots.

[h] There was an average of 9,160 producing wells

[c] Includes macadam, crushed rock, ballast, rubble, riprap, sand and gravel.

[d] Includes asbestos (1), bituminous rock (3), bromine (1), calcium chloride (2), chromite (1), diatomite (4), graphite (1), magnesite (2), magnesium salts (2), mica (1), potash (1), pyrite (1), sillimanite-andalusite-cyanite group (2), slate (3), sulphur (2), tungsten ore (2), and tube-mill pebbles (1).

[e] Also see gold.

[f] See copper, gold and lead, as silver is a by-product of these metals.

Distribution by counties is given in the following tabulation.

County	*Value*	*County*	*Value*
Alameda	$1,765,139	Orange	$14,182,245
Alpine	1,995	Placer	240,248
Amador	1,400,286	Plumas	181,312
Butte	464,512	Riverside	1,681,855
Calaveras	735,199	Sacramento	2,339,923
Colusa	38,053	San Benito	199,924
Contra Costa	1,013,993	San Bernardino	6,043,335
Del Norte	25,801	San Diego	375,176
El Dorado	594,902	San Francisco	3,903
Fresno	3,744,391	San Joaquin	270,492
Glenn	8,714	San Luis Obispo	249,930
Humboldt	117,475	San Mateo	1,343,450
Imperial	251,727	Santa Barbara	7,583,197
Inyo	724,023	Santa Clara	321,627
Kern	28,069,925	Santa Cruz	1,047,766
Kings	22,720,986	Shasta	610,986
Lake	97,084	Sierra	607,872
Lassen	109,568	Siskiyou	184,019
Los Angeles	76,721,115	Solano	36,202
Madera	298,021	Sonoma	167,849
Marin	253,837	Stanislaus	333,482
Mariposa	379,254	Sutter	----------
Mendocino	101,669	Tehama	14,387
Merced	749,742	Trinity	325,275
Modoc	51,002	Tulare	116,074
Mono	135,680	Tuolumne	300,458
Monterey	166,297	Ventura	14,855,606
Napa	169,633	Yolo	21,625
Nevada	3,704,103	Yuba	989,149
		Total	$199,196,493

MUSEUM

The Museum of the State Division of Mines possesses an exceptionally fine collection of rocks and minerals of both economic and academic value. It ranks among the first five of such collections in North America and contains not only specimens of most of the known minerals found in California but much valuable and interesting material from other states and foreign countries as well.

Mineral specimens suitable for exhibit purposes are solicited, and their donation will be appreciated by the State Division of Mines as well as by those who utilize the facilities of the collection.

The exhibit is daily visited by engineers, students, business men, and prospectors as well as tourists and mere sightseers. Beside its practical use in the economic development of California's mineral resources, the collection is a most valuable educational asset to the State and to San Francisco.

During 1932 there were 65,297 people who visited the Museum and Library of the Division of Mines in San Francisco. Among these there were many men who were forced by conditions to find new means of livelihood, and resorted to prospecting. They were able to observe here how all minerals, ores and rocks appear, thereby having a better knowledge of what they will find in the hills; also what minerals and rocks look like as described in various reports and books.

LABORATORY

FRANK SANBORN, Mineral Technologist

The laboratory of the Division of Mines is maintained for the purpost of identifying minerals and making quantitative analyses of rocks. These determinations and analyses are made without cost to those who seek the services of this State department. Ordinarily, a small sample weighing not over half a pound, in the lump form if possible, should be submitted with a letter stating what particular tests are desired, if there is a special reason for sending the material. Not more than three samples should be sent at one time, nor is it necessary to send more than one. Information regarding the size of the deposit and its proximity to rail transportation is useful in determining the possible value of a mineral body.

When requested, assistance in finding a market for a mineral will be given. When such help is desired, a small representative sample of the material for which a market is sought should accompany the request. The Division is often able to send a very small sample of a particular mineral for comparative purposes to any earnest prospector. Very small pieces of certain silicates, such as andalusite, have been supplied to those desiring them.

Determinations made by the Division of Mines during 1932 totaled 6248. Prospecting and exploitation of the State's mineral wealth increases as the State becomes more thickly populated. Each year new occurrences of some mineral in the State are reported and occasionally a new mineral species is found. New uses for a mineral are frequently found, and as a result stimulus is given to searching for that particular substance.

In the present economic distress many are seeking through hand methods of placer mining the wherewithal to purchase even food for themselves. Besides some 10,000 separate pieces of printed matter covering such information supplied through the offices of the Division of Mines, a total of 1200 persons were taught and had demonstrated the rudiments of placering last year in the laboratory of the Division in San Francisco.

LIBRARY

Herbert A. Franke, Librarian

In addition to the numerous standard works, authoritative information on many phases of the mining and mineral industry is constantly being issued in the form of reports and bulletins by various government agencies.

The library of the Division of Mines contains some six thousand selected volumes on mines, mining and allied subjects, and it is also a repository for reports and bulletins of the technical departments of federal and State governments and of educational institutions, both domestic and foreign.

It is not the dearth of the latter publications, but rather a lack of knowledge of just what has been published and where the reports may be consulted or obtained, that embarrasses the ordinary person seeking specific information.

To assist in making the public acquainted with this valuable source of current technical information, MINING IN CALIFORNIA contains under this heading a list of all books and official reports and bulletins received, with names of publishers or issuing departments.

Files of all the leading technical journals will be found in the library, and county and State maps, topographical sheets and geological folios. Current copies of local newspapers published in the mining centers of the State are available for reference.

The library and reading room are open to the public during the usual office hours, when the librarian may be freely called upon for all necessary assistance.

OFFICIAL PUBLICATIONS RECEIVED

Governmental, National.

U. S. Geological Survey:

Bulletins:

830–B—Geology of the Robertson, Humdinger, and Robert E. Gold Mines, Southwestern Oregon. By P. J. Shenon.
831 —Contributions to Economic Geology, 1931–1932, Part II.
836–D—The Eastern Portion of Mount McKinley National Park. By S. R. Capps.
The Kantishna District and Mining Development in the Tatlanika and Totatlanika Basins. By F. H. Moffit.
840 —Geology and Mineral Resources of the Middletown Quadrangle, Pennsylvania. By G. W. Stose and A. I. Jonas.
841 —Geology and Oil Possibilities of the Moab District, Grand and San Juan counties, Utah. By A. A. Baker.
844–A—Mineral Industry of Alaska in 1931 and Administrative Report. By P. S. Smith.
844–B—Mineral Investigations in the Alaska Railroad Belt, 1931. By S. R. Capps.
849–A—Progress of Surveys in the Anthracite Ridge District, Alaska. By R. W. Richards and G. A. Waring.

Professional Papers:
175–A—Miocene Foraminifera of the Coastal Plain of the Eastern United States. By J. A. Cushman and E. D. Cahill.
175–B—Some of the Alpheus Hyatt's Unfigured Types from the Jurassic of California. By C. H. Crickmay.
175–C—Replacement Origin of the Albite Granite near Sparta, Oregon. By J. Gilluly.

Water Supply Papers:
644 —St. Lawrence River Basin.
645 —Part 5—Hudson Bay and Upper Mississippi River Basins.
646 —Part 6—Missouri River Basin.
659 —Contributions to the Hydrology of the United States, 1932.
710 —Surface Water Supply of Hawaii.
711 —Part 1—North Atlantic Slope Drainage Basins.
712 —Part 2—South Atlantic Slope and Eastern Gulf of Mexico Basins.
713 —Part 3—Ohio River Basin.
714 —Part 4—St. Lawrence River Basin.
715 —Hudson Bay and Upper River Basins.
716 —Part 6—Missouri River Basin.
717 —Part 7—Lower Mississippi River Basin.
718 —Part 8—Western Gulf of Mexico Basins.
719 —Part 9—Colorado River Basin.
721 —Part 11—Pacific Slope Basins in California.
722 —Part 12—North Pacific Slope Drainage Basins.
723 —Part 12—North Pacific Slope Drainage Basins.
724 —Part 12—Pacific Slope Basins in Oregon and Lower Columbia River Basin.
725 —Surface Water-Supply of Hawaii.

Circulars:
1 —Iron Ore in the Red Mountain Formation in Greasy Cove, Alabama. By E. F. Burchard.

Alaska, Juneau:
Mining Investigations and Mine Inspection in Alaska. (Including Assistance to Prospectors.) By B. T. Stewart, Supervising Mining Engineer.

U. S. Bureau of Mines:

Bulletins:
351 —Mining Petroleum by Underground Methods. By G. S. Rice.

Technical Papers:
527 —Compressibility and Bearing Strength of Coal in Place:
Tests of Lateral Compression of Pittsburgh Coal Bed.
532 —Accidents at Metallurgical Works in the U. S., 1931. By W. W. Adams.
539 —Deviation of Natural Gas from Boyles Law. By Johnson and Berwald.
542 —Carbonizing Properties and Constitution of Chilton Bed Coal from Boone No. 2 Mine, Logan Co., West Va.
544 —Explosive Properties of Acetone-Air Mixtures. By Jones, Harris and Miller.
545 —Silicosis and Tuberculosis among Miners of the Tri-State District of Oklahoma, Kansas and Missouri. By Sayers, Meriwether, Lanza and Adams.
546 —Theory of the Torsion Balance. By J. W. Joyce.
547 —Falls of Roof in Mines Operating in the Pittsburgh Coal Bed, West Virginia. By J. W. Paul and J. N. Geyer.
549 —Unwatering Flooded Coal Mines in Washington. By S. H. Ash and T. Murphy.
550 —A Study of Roof in Pennsylvania Mines Contiguous to the Monongahela River. By Paul & Calverley.

552 —Silicosis and Tuberculosis among Miners of the Tri-State District of Oklahoma, Kansas and Missouri. By Meriwether, Sayers and Lanza.
553 —Protection of Equipment Containing Explosive Acetone-Air Mixtures by the use of Diaphragms. By Jones, Harris and Beattie.

Mineral Resources of the United States:

Asphalt and Related Bitumens in 1931.
Barite and Barium Products in 1931.
Clay in 1931.
Coal in 1931.
Coke and By-Products in 1931.
Gold, Silver, Copper, Lead and Zinc in Arizona in 1931.
Gold, Silver, Copper, Lead and Zinc in Idaho and Washington in 1931.
Gold, Silver, Copper, Lead and Zinc in Montana in 1931.
Gold, Silver, Copper, Lead and Zinc in New Mexico and Texas in 1931.
Gypsum in 1931.
Lead in 1931.
Lime in 1931.
Magnesium and Its Compounds in 1931.
Mica in 1931.
Natural Gasoline in 1931.
Natural Gas in 1931.
Sand and Gravel in 1931.
Secondary Metals in 1931.
Silver, Copper, Lead and Zinc in the Central States in 1931.
Stone in 1931.
Tin in 1931.
Zinc in 1931.

Report of Investigations:

3194—Inflammable Gases Produced by Thermal Decomposition of Plastic Insulators in an Electric Arc. By J. B. Littlefield and W. P. Yant.
3195—Selective Oiling and Table Concentration of Phosphatic Sands in the Land-Pebble District of Florida. By R. G. O'Meara and J. W. Pamplin.
3199—A Study of Falls of Roof and Coal in Northern Colorado. By H. Tomlinson.
3200—Washability Studies of the Blue Creek Bed at the Connellsville Mine, Connellsville, Ala. By B. W. Gandrud, A. C. Richardson and W. G. Payne.
3201—Explosive Shattering of Minerals. By R. S. Dean and John Gross.
3202—Notice of Official Changes in the Active List of Permissible Explosives and Blasting Devices Approved Prior to Jan. 31, 1933. By U. S. Bureau of Mines.
3203—Places of Occurrence of Injury from Falls of Roof. By J. W. Paul and D. L. Sibray.
3204—Washability Studies of the Mary Lee Bed at the Powhatan Mine, Powhatan, Ala. By A. C. Richardson and W. H. Carringtón.
3205—The Development of an Electrolytic Method for the Determination of Inclusions in Plain-Carbon Steels. By G. R. Fitterer, B. E. Sockman, E. A. Krockenberger, R. B. Meneilly, E. W. Marshall, Jr., and J. F. Eckel.
3206—Washability Studies of Coal from the Mary Lee Bed at the Bankhead Mine, Bankhead, Ala. By A. C. Richardson and B. W. Gandrud.
3207—A Study of Falls of Roof and Coal, Rock Springs Coal District, Sweetwater County, Wyo. By H. Tomlinson.
3208—Review of Fatalities in the California Petroleum Industry During the Calendar Year, 1932. By R. L. Marek.
3209—The Cleaning of Fine Coal From the Mary Lee Bed at the Porter Mine. By A. C. Richardson and B. W. Gandrud.
3211—A Study of Subsurface Pressures and Temperatures in Flowing Wells in the East Texas Field and the Application of These Data to Reservoir and Vertical-Flow Problems. By C. E. Reistle, Jr., and E. P. Hayes.

3212—A Study of "Bottom-Hole" Samples of East Texas Crude Oil. By Ben E. Lindsley.
3216—Limits of Inflammability of Natural Gases Containing High Percentages of Carbon Dioxide and Nitrogen. By G. W. Jones and R. E. Kennedy.

Information Circulars:

6607—Mining Treatment Methods and Costs at the Plant of the Consolidated Rock Products Co., Durbin, Calif. By Harry D. Jumper.
6608—Methods and Costs of Quarrying, Crushing, and Grinding Limestone at the Plant of the Southwestern Portland Cement Co., El Paso, Texas. By Robert T. Mann.
6610—Method and Cost of Quarrying Limestone at the Plant of the Calaveras Cement Co., San Andreas, Calif. By Robert H. Townsend.
6644—Mining Laws of Siam. By E. P. Youngman.
6664—Accident Experience and Cost in Tennessee Coal Mines. By F. E. Cash.
6668—Prospecting and Exploration for Sand and Gravel. By J. R. Thoenen.
6670—The International Conference on Mine Safety Research at Buxton, England, July, 1931. By Geo. S. Rice.
6671—Safety Progress in Anthracite and Bituminous Coal Fields. By D. Harrington.
6672—Ten Years of Fatal Accidents and Two Years of Accident Costs in Indiana Coal Mining. By C. A. Herbert.
6673—Methods and Costs of Mining Ferberite Ore at the Cold Springs Mine, Nederland, Boulder County, Colo. By Wm. O. Vanderburg.
6674—Shaft Sinking Methods and Costs and Cost of Plant and Equipment at the Macassa Mine, Kirkland Lake, Ontario. By G. A. Howes and Chas. F. Jackson.
6675—Safety Practices at Mine 1, Spring Canyon Coal Co., Utah. By D. J. Parker.
6676—Method and Cost of Mining Sand and Gravel at the Farmington (Conn.) Plant of the Atlas Sand Gravel and Stone Co. By John S. Dunning.
6677—Working an Underground Mine Six Years Without Lost Time Accidents. By C. A. Herbert.
6678—Metal-Mine Fires and Ventilation. By D. Harrington.
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6682—The Present Status of the Mineral Industry. By Scott Turner.
6683—Mining Laws of Iraq. By E. P. Youngman.
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6687—Growth and Development of the Nonmetallic Mineral Industries. By Oliver Bowles and C. W. Justice.
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6690—An International Viewpoint on Safeguarding Electrical Equipment Used in Gassy Mines. By L. C. Ilsley, E. J. Gleim and F. Craven.
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6694—Mining Laws of Tunisia. By R. M. Santmyers.
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6696—Dredging Methods and Costs of the Ross Island Sand & Gravel Co., Portland, Oregon. By Otis E. Perkins.
6697—Mining Laws of Syria. By Paul M. Tyler.
6698—Mining Laws of French Indio-China. By E. P. Youngman.
6699—List of Permissible Mine Equipment. By L. C. Ilsley.
6700—Mining Laws of Chosen (or Korea). By E. P. Youngman.
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6702—Mining Laws of Luxemburg. By E. P. Youngman.
6703—Mining Laws of Sweden. By E. P. Youngman.
6704—Mining Laws of French Guiana. By Paul M. Tyler.
6705—Mining Methods and Costs at Plant C, Eliot, Calif., of the Pacific Coast Aggregates (Inc.). By Edward B. Kendall.
6706—Milling Methods and Costs at the San Guillermo Concentrator of the Compania Industrial "El Potosi," S. A., San Guillermo, Chihuahua, Mexico. By C. A. Mehring, F. G. Bacon and Oba Wiser.
6707—Methods and Costs of Developing and Equipping the Ashley Gold Mine, Matachewan, Gold District, Ontario. By W. H. Emens and Chas. F. Jackson.
6708—Diamond Drilling at the United Verde Mine. By Mayer G. Hansen.
6709—Mining Methods and Costs at Granada Gold Mines (Ltd.), Rouyn, Quebec. By R. L. Loofbourow.
6710—Explosions in Pennsylvania Coal Mines, 1870–1932. By J. J. Forbes and H. B. Humphrey.
6711—Mining Laws of New Caledonia and French Oceania. By Paul M. Tyler.
6712—Portable Electric Lamps for Animal Haulage in Alabama. By F. E. Cash and C. E. Saxon.
6713—Accident Experience and Costs in Colorado Metal Mines. By E. H. Denny and E. A. Anundsen.
6714—Flotation Processes for Cleaning Fine Coal. By H. F. Yancey and J. A. Taylor.
6715—Mining Laws of Ceylon. By E. P. Youngman.
6716—Mining Laws of French Equatorial Africa, West Africa, Cameroun and Togo. By Paul M. Tyler.
6717—Mining Laws of Surinam (Dutch Guiana). By E. P. Youngman.
6718—Mining Laws of Madagascar. By R. M. Santmyers.
6719—Mining Laws of Bulgaria. By R. M. Santmyers.
6720—Vermiculite. By A. V. Petar.
6721—Accident Experience of Four Louisiana Petroleum Refineries. By F. E. Cash.
6724—Protective Clothing in the Mining Industry. By R. D. Currie and W. J. Fene.
6725—Explosives Accidents in California Metal Mines. By S. H. Ash.
6726—Safety Practices in Tunneling Operations at the Hetch Hetchy Water-Supply Project, City and County of San Francisco, Calif. By S. H. Ash and C. R. Rankin.
6728—Petroleum Refineries, Including Cracking Plants, in the U. S. Jan. 1, 1933. By G. R. Hopkins and E. W. Cochrane.
6734—Metal-Mine Ventilation. By D. Harrington.

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No. 3211—Some Texas Fusulinidae. By M. P. White.

No. 3224—The Geology of Wise County, Texas. By Scott and Armstrong.

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Bulletin 38—Kyanite in Virginia.

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  Bulletins.

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  Vol. VII, Nos. 18 and 19.
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  Vol. VII, No. 21—Notes on the Foraminifera of the Type Merced at Seven Mile Beach, San Mateo County, California. By R. E. and K. C. Stewart.

No. 22—A New Species of Echinoid from Tamaulipas, Mexico. By M. C. Israilsky. A new Gryphaeoid Oyster From the Eocene of California. By L. G. Hertlein.

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  Conner Quadrangle, Kern Co.
  Casa Desierta Quadrangle, Los Angeles Co.
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  Lancaster Quadrangle, Los Angeles Co.
  Lovejoy Springs Quadrangle, Los Angeles Co.
  Moon Mtn. Quadrangle.
  Newhall Quadrangle, Los Angeles Co.
  Newport Beach Quadrangle, Orange Co.
  Oban Quadrangle, Los Angeles Co.
  Roosevelt School Quadrangle, Los Angeles Co.
  Rosedale Quadrangle, Los Angeles Co.
  Tierra Bonita Quadrangle, Los Angeles Co.
  Tupman Quadrangle, Kern Co.
  Tusin Quadrangle, Orange Co.
  Saugus Quadrangle, Los Angeles Co.
  Weed Patch Quadrangle, Kern Co.
  West Alpine Butte Quadrangle, Los Angeles Co.

Montana:
  Libby Quadrangle.

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  Bertram Quadrangle.
  Clifton by the Sea Quadrangle.
  Harlingen Quadrangle.
  Mt. Bonnell Quadrangle.
  Seabrook Quadrangle.
  Spicewood Quadrangle.
  Virginia Quadrangle.

Current Magazines on File.

For the convenience of persons wishing to consult the technical magazines in the reading room, a list of those on file is appended:

Asbestos, Philadelphia, Pennsylvania.
Brick and Clay Record, Chicago, Illinois.
California Journal of Development, San Francisco.
California Mining Journal, Auburn.
California Oil World, Los Angeles.
California Safety News, San Francisco.
Canadian Mining Journal, Gardenvale, Quebec.
Chemical Engineering and Mining Review, Melbourne, Australia.
Chemical and Metallurgical Engineering, New York City.
Commerce Reports, Washington, D. C.
Colorado School of Mines, Golden, Colorado.
Engineering and Mining Journal, New York City.
Fuel Oil, Chicago, Illinois.
Fusion Facts, Whittier.
Grizzly Bear, Los Angeles.
Hercules Mixer, Wilmington, Delaware.
Independent Monthly, Tulsa, Oklahoma.
Industrial Employment Information Bulletin, Washington, D. C.
Lubrication, The Texas Co., New York City.
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National Sand and Gravel, Washington, D. C.

Nickel Cast Iron News, New York City.
Oil and Gas Journal, Tulsa, Oklahoma.
Oil, Paint and Drug Reporter, New York City.
Oil Weekly, Houston, Texas.
Pacific Purchaser, San Francisco.
Petroleum World, Los Angeles.
Pit and Quarry, Chicago, Illinois.
Queensland Government Mining Journal, Brisbane, Australia.
Rock Products, Chicago, Illinois.
Rocks and Minerals, Peekskill, New York.
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Standard Oil Bulletin, San Francisco.
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Gold Miner, Los Angeles, California.
Goldfield News, Goldfield, Nevada.
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Inyo Independent, Independence, California.
Inyo Register, Bishop, California.
Ione Valley Echo, Ione, California.
Kettleman Oil and Gas News, Kettleman City, California.
Las Vegas Age, Las Vegas, Nevada.
Livermore Herald, Livermore, California.
Mariposa Gazette, Mariposa, California.
Mercury Register, Oroville, California.
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Mojave Miner, Kingman, Arizona.
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National Industrial Review, San Franicsco, California.
Needles Nugget, Needles, California.
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Nevada Mining Press, Reno, Nevada.
Northern Miner, Toronto, Canada.
Oil Marketer, Bayonne, New Jersey.
Oil Refinery News, Bayonne, New Jersey.
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Placer Herald, Auburn, California.
Plumas Independent, Quincy, California.
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Shasta Courier, Redding, California.
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Stockton Record, Stockton, California.
Tehachapi News, Tehachapi, California.
Terra Bella News, Terra Bella, California.
Tuolumne Independent, Tuolumne, California.
Tuolumne Prospector, Tuolumne, California.
Union-Democrat, Sonora, California.
Ventura County News, Ventura, California.
Waterford News, Waterford, California.
Weekly Trinity Journal, Weaverville, California.
Western Mineral Survey, Salt Lake City, Utah.
Western Sentinel, Etna Mills, California.

PRODUCERS AND CONSUMERS

The producer and consumer of mineral products are mutually dependent upon each other for their prosperity, and one of the most direct aids rendered by the Bureau to the mining industry in the past has been that of bringing producers and consumers into direct touch with each other.

This work has been carried on largely by correspondence, supplemented by personal consultation. Lists of buyers of all the commercial minerals produced in California have been made available to producers upon request, and likewise the owners of undeveloped deposits of various minerals, and producers of them, have been made known to those looking for raw mineral products.

When the publication of Mining in Caifornia was on a monthly basis, current inquiries from buyers and sellers were summarized and lists of mineral products or deposits 'wanted' or 'for sale' included in each issue.

It is important that inquiries of this nature reach the mining public as soon as possible and in order to avoid the delay incident to the present quarterly publication of *California Journal of Mines and Geology,* these lists are now issued monthly in the form of a mimeographed sheet under the title of 'Commercial Mineral Notes,' and sent to those on the mailing list of *California Journal of Mines and Geology.*

EMPLOYMENT SERVICE

Following the establishment of the Mining Division branch offices in 1919, a free technical employment service was offered as a mutual aid to mine operators and technical men for the general benefit of the mineral industry.

Briefly summarized, men desiring positions are registered, the cards containing an outline of the applicant's qualifications, position wanted, salary desired, etc., and as notices of 'positions open' are received, the names and addresses of all applicants deemed qualified are sent to the prospective employer for direct negotiations.

Telephone and telegraphic communications are also given immediate attention.

Technical men, or those qualified for supervisory positions, and vacancies of like nature only, are registered, as no attempt will be made to supply common mine and mill labor.

Registration cards for the use of both prospective employers and employees may be obtained upon request, and a cordial invitation is extended to the industry to make free use of the facilities afforded. Parties interested should communicate direct with our San Francisco office.

PUBLICATIONS OF THE DIVISION OF MINES

During the past fifty-one years, in carrying out the provisions of the organic act creating the former California State Mining Bureau, there have been published many reports, bulletins and maps which go to make up a library of detailed information on the mineral industry of the State, a large part of which could not be duplicated from any other source.

One feature that has added to the popularity of the publications is that many of them have been distributed without cost to the public, and even the more elaborate ones have been sold at a price which barely covers the cost of printing.

Owing to the fact that funds for the advancing of the work of this department have often been limited, many of the reports and bulletins mentioned were printed in limited editions which are now entirely exhausted.

Copies of such publications are available, however, in the offices of the Division of Mines, in the Ferry Building, San Francisco; Bankers Building, Los Angeles; State Office Building, Sacramento; Redding; and Division of Oil and Gas, Santa Barbara; Santa Paula; Coalinga; Taft, Bakersfield. They may also be found in many public, private and technical libraries in California and other States and foreign countries.

A catalog of all publications from 1880 to 1917, giving a synopsis of their contents, is issued as Bulletin No. 77.

Publications in stock may be obtained by addressing any of the above offices and enclosing the requisite amount in the case of publications that have a list price. Only coin, stamps or money orders should be sent, and it will be appreciated if remittance is made in this manner rather than by personal check.

Money orders should be made payable to the Division of Mines.

NOTE.—The Division of Mines frequently receives requests for some of the early Reports and Bulletins now out of print, and it will be appreciated if parties having such publications and wishing to dispose of them will advise this office.

REPORTS

Asterisks (**) indicate the publication is out of print.

	Price	Shipping Charges
**First Annual Report of the State Mineralogist, 1880, 43 pp. Henry G. Hanks	----	----
**Second Annual Report of the State Mineralogist, 1882, 514 pp., 4 illustrations, 1 map. Henry G. Hanks	----	----
**Third Annual Report of the State Mineralogist, 1883, 111 pp., 21 illustrations. Henry G. Hanks	----	----
**Fourth Annual Report of the State Mineralogist, 1884, 410 pp., 7 illustrations. Henry G. Hanks	----	----
**Fifth Annual Report of the State Mineralogist, 1885, 234 pp., 15 illustrations, 1 geological map. Henry G. Hanks	----	----
**Sixth Annual Report of the State Mineralogist, Part I, 1886, 145 pp., 3 illustrations, 1 map. Henry G. Hanks	----	----
**Part II, 1887, 222 pp., 36 illustrations. William Irelan, Jr.	----	----
**Seventh Annual Report of the State Mineralogist, 1887, 315 pp. William Irelan, Jr.	----	----
**Eighth Annual Report of the State Mineralogist, 1888, 948 pp., 122 illustrations. William Irelan, Jr.	----	----
**Ninth Annual Report of the State Mineralogist, 1889, 352 pp., 57 illustrations, 2 maps. William Irelan, Jr.	----	----
**Tenth Annual Report of the State Mineralogist, 1890, 983 pp., 179 illustrations, 10 maps. William Irelan, Jr.	----	----
Eleventh Report (First Biennial) of the State Mineralogist, for the two years ending September 15, 1892, 612 pp., 73 illustrations, 4 maps. William Irelan, Jr.	$1.00	$0.20
**Twelfth Report (Second Biennial) of the State Mineralogist, for the two years ending September 15, 1894, 541 pp., 101 illustrations, 5 maps. J. J. Crawford	----	----
**Thirteenth Report (Third Biennial) of the State Mineralogist, for the two years ending September 15, 1896, 726 pp., 93 illustrations, 1 map. J. J. Crawford	----	----
Chapters of the State Mineralogist's Report, Biennial Period, 1913–1914, Fletcher Hamilton:		
**Mines and Mineral Resources, Amador, Calaveras and Tuolumne Counties, 172 pp., paper	----	----
Mines and Mineral Resources, Colusa, Glenn, Lake, Marin, Napa, Solano, Sonoma and Yolo Counties, 208 pp., paper	.50	.10
**Mines and Mineral Resources, Del Norte, Humboldt and Mendocino Counties, 59 pp., paper	----	----
**Mines and Mineral Resources, Fresno, Kern, Kings, Madera, Mariposa, Merced, San Joaquin and Stanislaus Counties, 220 pp., paper	----	----
**Mines and Mineral Resources of Imperial and San Diego Counties, 113 pp., paper	----	----
**Mines and Mineral Resources, Shasta, Siskiyou and Trinity Counties, 180 pp., paper	----	----
**Fourteenth Report of the State Mineralogist, for the Biennial Period 1913–1914, Fletcher Hamilton, 1915: A General Report on the Mines and Mineral Resources of Amador, Calaveras, Tuolumne, Colusa, Glenn, Lake, Marin, Napa, Solano, Sonoma, Yolo, Del Norte, Humboldt, Mendocino, Fresno, Kern, Kings, Madera, Mariposa, Merced, San Joaquin, Stanislaus, San Diego, Imperial, Shasta, Siskiyou and Trinity Counties, 974 pp., 275 illustrations, cloth	----	----
Chapters of the State Mineralogist's Report, Biennial Period, 1915–1916. Fletcher Hamilton:		
**Mines and Mineral Resources, Alpine, Inyo and Mono Counties, 176 pp., paper	----	----
Mines and Mineral Resources, Butte, Lassen, Modoc, Sutter and Tehama Counties, 91 pp., paper	.50	.05
**Mines and Mineral Resources, El Dorado, Placer, Sacramento and Yuba Counties, 198 pp., paper	----	----
**Mines and Mineral Resources, Monterey, San Benito, San Luis Obispo, Santa Barbara and Ventura Counties, 183 pp., paper	----	----
**Mines and Mineral Resources, Los Angeles, Orange and Riverside Counties, 136 pp., paper	----	----
**Mines and Mineral Resources, San Bernardino and Tulare Counties, 186 pp., paper	----	----

REPORTS—Continued

Asterisks (**) indicate the publication is out of print.

	Price	Shipping Charges
**Fifteenth Report of the State Mineralogist, for the Biennial Period 1915–1916, Fletcher Hamilton, 1917: A General Report on the Mines and Mineral Resources of Alpine, Inyo, Mono, Butte, Lassen, Modoc, Sutter, Tehama, Placer, Sacramento, Yuba, Los Angeles, Orange, Riverside, San Benito, San Luis Obispo, Santa Barbara, Ventura, San Bernardino and Tulare Counties, 990 pp., 413 illustrations, cloth	----	----
Chapters of the State Mineralogist's Report, Biennial Period, 1917–1918, Fletcher Hamilton:		
Mines and Mineral Resources of Nevada County, 270 pp., paper	$0.75	$0.15
Mines and Mineral Resources of Plumas County, 188 pp., paper	.50	.10
Mines and Mineral Resources of Sierra County, 144 pp., paper	.50	.10
Seventeenth Report of the State Mineralogist, 1920, 'Mining in California during 1920,' Fletcher Hamilton; 562 pp., 71 illustrations, cloth	1.75	.25
Eighteenth Report of the State Mineralogist, 1922, 'Mining in California,' Fletcher Hamilton. Chapters published monthly beginning with January, 1922:		
**January, **February, **March, **April, **May, **June, July, August, September, October, **November, December, 1922	.25	.05
Chapters of Nineteenth Report of the State Mineralogist, 'Mining in California,' Fletcher Hamilton and Lloyd L. Root. January, February, March, September, 1923	.25	.05
Chapters of Twentieth Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly. January, April, **July, October, 1924, per copy	.25	.05
Chapters of Twenty-first Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly:		
January, 1925, Mines and Mineral Resources of Sacramento, Monterey and Orange Counties	.25	.05
April, 1925, Mines and Mineral Resources of Calaveras, Merced, San Joaquin, Stanislaus and Ventura Counties	.25	.05
July, 1925, Mines and Mineral Resources of Del Norte, Humboldt and San Diego Counties	.25	.10
**October, 1925, Mines and Mineral Resources of Siskiyou, San Luis Obispo and Santa Barbara Counties	----	----
Chapters of Twenty-second Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly:		
**January, 1926, Mines and Mineral Resources of Trinity and Santa Cruz Counties	----	----
April, 1926, Mines and Mineral Resources of Shasta, San Benito and Imperial Counties	.25	.10
July, 1926, Mines and Mineral Resources of Marin and Sonoma Counties	.25	.05
**October, 1926, Mines and Mineral Resources of El Dorado and Inyo Counties, also report on Minaret District, Madera County	----	----
Chapters of Twenty-third Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly:		
January, 1927, Mines and Mineral Resources of Contra Costa County; Santa Catalina Island	.25	.10
April, 1927, Mines and Mineral Resources of Amador and Solano Counties	.25	.05
July, 1927, Mines and Mineral Resources of Placer and Los Angeles Counties	.25	.10
October, 1927, Mines and Mineral Resources of Mono County	.25	.05
Chapters of Twenty-fourth Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly:		
January, 1928, Mines and Mineral Resources of Tuolumne County	.25	.05
April, 1928, Mines and Mineral Resources of Mariposa County	.25	.05
July, 1928, Mines and Mineral Resources of Butte and Tehama Counties	.25	.05
October, 1928, Mines and Mineral Resources of Plumas and Madera Counties	.25	.05
Chapters of Twenty-fifth Report of the State Mineralogist, 'Mining in California,' Walter W. Bradley. Published quarterly:		
**January, 1929, Mines and Mineral Resources of Lassen, Modoc and Kern Counties; also on Special Placer Machines	----	----

REPORTS—Continued

Asterisks (**) indicate the publication is out of print.

	Price	Shipping Charges
April, 1929, Mines and Mineral Resources of Sierra, Napa, San Francisco and San Mateo Counties	$0.25	$0.10
July, 1929, Mines and Mineral Resources of Colusa, Fresno and Lake Counties	.25	.10
October, 1929, Mines and Mineral Resources of Glenn, Alameda, Mendocino and Riverside Counties	.25	.10
Chapters of Twenty-sixth Report of the State Mineralogist, 'Mining in California,' Walter W. Bradley. Published quarterly:		
January, 1930, Mines and Mineral Resources of Santa Clara County; also Barite in California	.25	.05
April, 1930, Mines and Mineral Resources of Nevada County; also Mineral Paint Materials in California	.25	.05
July, 1930, Mines and Mineral Resources of Yuba and San Bernardino Counties; also Commercial Grinding Plants in California	.25	.10
October, 1930, Mines and Mineral Resources of Butte, Kings and Tulare Counties; also Geology of Southwestern Mono County (Preliminary)	.25	.10
Chapters of Twenty-seventh Report of the State Mineralogist, 'Mining in California,' Walter W. Bradley. Published quarterly:		
January, 1931, Preliminary Report on Economic Geology of the Shasta Quadrangle. Beryllium and Beryl. The New Tariff and Nonmetallic Products. Crystalline Talc. Decorative Effects in Concrete	.25	.10
April, 1931, Stratigraphy of the Kreyenhagen Shale. Diatoms and Silicoflagellates of the Kreyenhagen Shale. Foraminifera of the Kreyenhagen Shale. Geology of Santa Cruz Island	.25	.10
July, 1931. (Yuba, San Bernardino.) Feldspar, Silica, Andalusite and Cyanite Deposits of California. Note on a Deposit of Andalusite in Mono County; its occurrence and chemical importance. Bill creating Trinity and Klamath River Fish and Game District and its effect upon mining	.25	.10
October, 1931. (Alpine.) Geology of the San Jacinto Quadrangle south of San Gorgonio Pass, California. Notes on Mining Activities in Inyo and Mono Counties in July, 1931	.25	.05
Chapters of Twenty-eighth Report of the State Mineralogist, 'Mining in California,' Walter W. Bradley. Published quarterly:		
January, 1932, Economic Mineral Deposits of the San Jacinto Quadrangle. Geology and Physical Properties of Building Stone from Carmel Valley. Contributions to the Study of Sediments. Sediments of Monterey Bay. Sanbornite	.25	.10
**April, 1932. Elementary Placer Mining Methods and Gold Saving Devices. The Pan, Rocker and Sluice Box. Prospecting for Vein Deposits. Bibliography of Placer Mining	----	----
Abstract from April quarterly: Elementary Placer Mining Methods and Gold Saving Devices. Types of Deposits. Simple Equipment. Special Machines. Dry Washing. Black Sand Treatment. Marketing of Products. Placer Mining Areas. Laws. Prospecting for Quartz Veins. Bibliography (mimeographed)	.20	.05
July-October. (Ventura.) Report accompanying Geologic Map of Northern Sierra Nevada. Fossil Plants in Auriferous Gravels of the Sierra Nevada. Glacial and Associated Stream Deposits of the Sierra Nevada. Jurassic and Cretaceous Divisions in the Knoxville-Shasta Succession of California. Geology of a Part of the Panamint Range. Economic Report of a Part of the Panamint Range. Acquiring Mining Claims Through Tax Title. The Biennial Report of State Mineralogist	.50	.15
Chapters of Report XXIX, 1933 (quarterly): titled "California Journal of Mines and Geology." containing the following:		
January-April. Gold Deposits of the Redding and Weaverville Quadrangles. Geologic Formations of the Redding-Weaverville District, Northern California. Geology of Portions of Del Norte and Siskiyou Counties. Applications of Geology to Civil Engineering. The Lakes of California. Limestone Deposits of San Francisco Region. Limestone		

REPORTS—Continued

Asterisks (**) indicate the publication is out of print.

	Price	Shipping Charges
Residual Soils of San Francisco Region. Discovery of Piedmontite in the Sierra Nevada. Tracing 'Buried River' Channel Deposits by Geomagnetic Methods. Geologic Map of Redding-Weaverville District, showing gold mines and prospects. Geologic Map showing various mines and prospects of part of Del Norte and Siskiyou Counties. Geologic Map of the San Francisco Region	$0.80	$0.15
Subscription, $1.50 in advance (by calendar year, only).		
Chapters of State Oil and Gas Supervisor's Report:		
Summary of Operations—California Oil Fields, July, 1918, to March, 1919 (one volume)	Free	----
Summary of Operations—California Oil Fields. Published monthly, beginning April, 1919:		
**April, **May, **June, **July, **August, **September, **October, **November, **December, 1919	----	----
**January, **February, **March, **April, **May, **June, **July, **August, **September, **October, **November, **December, 1920	----	----
January, **February, **March, April, **May, **June, **July, August, **September, **October, **November, **December, 1921	Free	----
January, February, March, April, May, **June, **July, **August, September, **October, **November, December, 1922	Free	----
January, **February, **March, **April, May, **June, **July, August, September, **October, November, December, 1923	Free	----
January, February, March, April, May, June, July, August, September, October, November, December, 1924	Free	----
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January, February, March, April, May, June, July-August-September, October-November-December, 1929	Free	----
(Published quarterly beginning July, 1929.)		
January-February-March, April-May-June, July-August-September, October-November-December, 1930	Free	----
January-February-March, April-May-June, July-August-September, 1931	Free	----

BULLETINS

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**Bulletin No. 2. Methods of Mine Timbering, by W. H. Storms. 1894, 58 pp., 75 illustrations	----	----
**Bulletin No. 3. Gas and Petroleum Yielding Formations of Central Valley of California, by W. L. Watts. 1894, 100 pp., 13 illustrations, 4 maps	----	----
**Bulletin No. 4. Catalogue of Californian Fossils, by J. G. Cooper, 1894, 73 pp., 67 illustrations. (Part I was published in the Seventh Annual Report of the State Mineralogist, 1887)	----	----
**Bulletin No. 5. The Cyanide Process, 1894, by Dr. A. Scheidel. 140 pp., 46 illustrations	----	----
**Bulletin No. 6. California Gold Mill Practices, 1895, by E. B. Preston, 85 pp., 46 illustrations	----	----
**Bulletin No. 7. Mineral Production of California, by Counties, for the year 1894, by Charles G. Yale. Tabulated sheet	----	----
**Bulletin No. 8. Mineral Production of California, by Counties, for the year 1895, by Charles G. Yale. Tabulated sheet	----	----
**Bulletin No. 9. Mine Drainage, Pumps, etc., by Hans C. Behr. 1896, 210 pp., 206 illustrations	----	----
**Bulletin No. 10. A bibliography Relating to the Geology, Paleontology and Mineral Resources of California, by Anthony W. Vogdes. 1896, 121 pp.	----	----
**Bulletin No. 11. Oil and Gas Yielding Formations of Los Angeles, Ventura and Santa Barbara Counties, by W. L. Watts. 1897, 94 pp., 6 maps, 31 illustrations	----	----
**Bulletin No. 12. Mineral Production of California, by Counties, for 1896, by Charles G. Yale. Tabulated sheet	----	----
**Bulletin No. 13. Mineral Production of California, by Counties, for 1897, by Charles G. Yale. Tabulated sheet	----	----
**Bulletin No. 14. Mineral Production of California, by Counties, for 1898, by Charles G. Yale	----	----
**Bulletin No. 15. Map of Oil City Fields, Fresno County, by John H. Means, 1899	----	----
**Bulletin No. 16. The Genesis of Petroleum and Asphaltum in California, by A. S. Cooper. 1899, 39 pp., 29 illustrations	----	----
**Bulletin No. 17. Mineral Production of California, by Counties, for 1899, by Charles G. Yale. Tabulated sheet	----	----
**Bulletin No. 18. Mother Lode Region of California, by W. H. Storms. 1900, 154 pp., 49 illustrations	----	----
**Bulletin No. 19. Oil and Gas Yielding Formations of California, by W. L. Watts. 1900, 236 pp., 60 illustrations, 8 maps	----	----
**Bulletin No. 20. Synopsis of General Report of State Mining Bureau, by W. L. Watts. 1901, 21 pp. This bulletin contains a brief statement of the progress of the mineral industry in California for the four years ending December, 1899	----	----
**Bulletin No. 21. Mineral Production of California by Counties, by Charles G. Yale. 1900. Tabulated sheet	----	----
**Bulletin No. 22. Mineral Production of California for Fourteen Years, by Charles G. Yale. 1900. Tabulated sheet	----	----
Bulletin No. 23. The Copper Resources of California, by P. C. DuBois, F. M. Anderson, J. H. Tibbits and G. A. Tweedy. 1902, 282 pp., 69 illustrations, 9 maps	$0.50	$0.20
**Bulletin No. 24. The Saline Deposits of California, by G. E. Bailey. 1902, 216 pp., 99 illustrations, 5 maps	----	----
**Bulletin No. 25. Mineral Production of California, by Counties, for 1901, by Charles G. Yale. Tabulated sheet	----	----
**Bulletin No. 26. Mineral Production of California for the Past Fifteen Years, by Charles G. Yale. 1902. Tabulated sheet	----	----

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Asterisks (**) indicate the publication is out of print.

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**Bulletin No. 27. The Quicksilver Resources of California, by William Forstner. 1903, 273 pp., 144 illustrations, 8 maps	----	----
**Bulletin No. 28. Mineral Production of California for 1902, by Charles G. Yale. Tabulated sheet	----	----
**Bulletin No. 29. Mineral Production of California for Sixteen Years, by Charles G. Yale. 1903. Tabulated sheet	----	----
**Bulletin No. 30. Bibliography Relating to the Geology, Paleontology and Mineral Resources of California, by A. W. Vogdes. 1903, 290 pp.	----	----
**Bulletin No. 31. Chemical Analyses of California Petroleum, by H. N. Cooper. 1904. Tabulated sheet	----	----
**Bulletin No. 32. Production and Use of Petroleum in California, by Paul W. Prutzman. 1904, 230 pp., 116 illustrations, 14 maps	----	----
**Bulletin No. 33. Mineral Production of California, by Counties, for 1903, by Charles G. Yale. Tabulated sheet	----	----
**Bulletin No. 34. Mineral Production of California for Seventeen Years, by Charles G. Yale. 1904. Tabulated sheet	----	----
**Bulletin No. 35. Mines and Minerals of California, by Charles G. Yale. 1904, 55 pp., 20 county maps. Relief map of California	----	----
**Bulletin No. 36. Gold Dredging in California, by J. E. Doolittle. 1905. 120 pp., 66 illustrations, 3 maps	----	----
**Bulletin No. 37. Gems, Jewelers' Materials, and Ornamental Stones of California, by George F. Kunz. 1905, 168 pp., 54 illustrations	----	----
**Bulletin No. 38. Structural and Industrial Materials of California, by Wm. Forstner, T. C. Hopkins, C. Naramore and L. H. Eddy. 1906, 412 pp., 150 illustrations, 1 map	----	----
**Bulletin No. 39. Mineral Production of California, by Counties, for 1904, by Charles G. Yale. Tabulated sheet	----	----
**Bulletin No. 40. Mineral Production of California for Eighteen Years, by Charles G. Yale. 1905. Tabulated sheet	----	----
**Bulletin No. 41. Mines and Minerals of California for 1904, by Charles G. Yale. 1905, 54 pp., 20 county maps	----	----
**Bulletin No. 42. Mineral Production of California, by Counties, 1905, by Charles G. Yale. Tabulated sheet	----	----
**Bulletin No. 43. Mineral Production of California for Nineteen Years, by Charles G. Yale. Tabulated sheet	----	----
**Bulletin No. 44. California Mines and Minerals for 1905, by Charles G. Yale. 1907, 31 pp., 20 county maps	----	----
**Bulletin No. 45. Auriferous Black Sands of California, by J. A. Edman. 1907. 10 pp.	----	----
**Bulletin No. 46. General Index of Publications of the California State Mining Bureau, by Charles G. Yale. 1907, 54 pp.	----	----
**Bulletin No. 47. Mineral Production of California, by Counties, 1906, by Charles G. Yale. Tabulated sheet	----	----
**Bulletin No. 48. Mineral Production of California for Twenty Years, by Charles G. Yale. 1906	----	----
**Bulletin No. 49. Mines and Minerals of California for 1906, by Charles G. Yale. 34 pp.	----	----
Bulletin No. 50. The Copper Resources of California, 1908, by A. Hausmann, J. Kruttschnitt, Jr., W. E. Thorne and J. A. Edman. 366 pp., 74 illustrations. (Revised edition)	$1.00	$0.25
**Bulletin No. 51. Mineral Production of California, by Counties, 1907, by D. H. Walker. Tabulated sheet	----	----
**Bulletin No. 52. Mineral Production of California for Twenty-one Years, by D. H. Walker. 1907. Tabulated sheet	----	----
**Bulletin No. 53. Mineral Production of California for 1907, with County Maps, by D. H. Walker. 62 pp.	----	----

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Asterisks (**) indicate the publication is out of print.

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**Bulletin No. 54. Mineral Production of California, by Counties, by D. H. Walker, 1908. Tabulated sheet	----	----
**Bulletin No. 55. Mineral Production of California for Twenty-two Years, by D. H. Walker, 1908. Tabulated sheet	----	----
**Bulletin No. 56. Mineral Production for 1908, with County Maps and Mining Laws of California, by D. H. Walker, 78 pp.	----	----
**Bulletin No. 57. Gold Dredging in California, by W. B. Winston and Chas. Janin. 1910, 312 pp., 239 illustrations, 10 maps	----	----
**Bulletin No. 58. Mineral Production of California, by Counties, by D. H. Walker. 1909. Tabulated sheet	----	----
**Bulletin No. 59. Mineral Production of California for Twenty-three Years, by D. H. Walker. 1909. Tabulated sheet	----	----
**Bulletin No. 60. Mineral Production for 1909, with County Maps and Mining Laws of California, by D. H. Walker. 94 pp.	----	----
**Bulletin No. 61. Mineral Production of California, by Counties, for 1910, by D. H. Walker. Tabulated sheet	----	----
**Bulletin No. 62. Mineral Production of California for Twenty-four Years, by D. H. Walker. 1910. Tabulated sheet	----	----
**Bulletin No. 63. Petroleum in Southern California, by P. W. Prutzman. 1912, 430 pp., 41 illustrations, 6 maps	----	----
**Bulletin No. 64. Mineral Production for 1911, by E. S. Boalich. 49 pp.	----	----
**Bulletin No. 65. Mineral Production for 1912, by E. S. Boalich. 64 pp.	----	----
**Bulletin No. 66. Mining Laws of the United States and California. 1914, 89 pp.	----	----
**Bulletin No. 67. Minerals of California, by Author S. Eakle. 1914, 226 pp.	----	----
**Bulletin No. 68. Mineral Production for 1913, with County Maps and Mining Laws, by E. S. Boalich. 160 pp.	----	----
**Bulletin No. 69. Petroleum Industry of California, with Folio of Maps (18 by 22), by R. P. McLaughlin and C. A. Waring. 1914, 519 pp., 13 illustrations, 83 figs. [18 plates in accompanying folio.]	----	----
**Bulletin No. 70. Mineral Production for 1914, with County Maps and Mining Laws. 184 pp.	----	----
**Bulletin No. 71. Mineral Production for 1915, with County Maps and Mining Laws, by Walter W. Bradley. 193 pp. 4 illustrations	----	----
**Bulletin No. 72. The Geologic Formations of California, by James Perrin Smith. 1916, 47 pp.	----	----
**Reconnaissance Geologic Map (of which Bulletin 72 is explanatory), in 23 colors. Scale: 1 inch = 12 miles. Mounted	----	----
**Bulletin No. 73. First Annual Report of the State Oil and Gas Supervisor of California, for the Fiscal Year 1915–16, by R. P. McLaughlin. 278 pp., 26 illustrations	----	----
Bulletin No. 74. Mineral Production of California in 1916, with County Maps, by Walter W. Bradley. 179 pp., 12 illustrations	Free	$0.15
**Bulletin No. 75. United States and California Mining Laws. 1917, 115 pp., paper	----	----
Bulletin No. 76. Manganese and Cromium in California, by Walter W. Bradley, Emile Huguenin, C. A. Logan, W. B. Tucker and C. A. Waring. 1918, 248 pp., 51 illustrations, 5 maps, paper	$0.50	.10
Bulletin No. 77. Catalogue of Publications of California State Mining Bureau, 1880–1917, by E. S. Boalich. 44 pp. paper	Free	.05
Bulletin No. 78. Quicksilver Resources of California, with a Section on Metallurgy and Ore-Dressing, by Walter W. Bradley. 1919, 389 pp., 77 photographs and 42 plates (colored and line cuts), cloth	1.50	.35
Bulletin No. 79. Magnesite in California, by Walter W. Bradley. 1925, 147 pp., 62 photographs, 11 line cuts and maps, cloth	1.00	.10

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†Bulletin No. 80. Tungsten, Molybdenum and Vanadium in California. (In preparation.)		
†Bulletin No. 81. Foothill Copper Belt of California. (In preparation.)		
**Bulletin No. 82. Second Annual Report of the State Oil and Gas Supervisor, for the Fiscal Year 1916–1917, by R. P. McLaughlin. 1918, 412 pp., 31 illustrations, cloth	----	----
Bulletin No. 83. California Mineral Production for 1917, with County Maps, by Walter W. Bradley. 179 pp., paper	Free	$0.15
**Bulletin No. 84. Third Annual Report of the State Oil and Gas Supervisor, for the Fiscal Year 1917–1918, by R. P. McLaughlin. 1918, 617 pp., 28 illustrations, cloth	----	----
**Bulletin No. 85. Platinum and Allied Metals in California, by C. A. Logan, 1919. 10 photographs, 4 plates, 120 pp., paper	----	----
Bulletin No. 86. California Mineral Production for 1918, with County Maps, by Walter W. Bradley. 1919, 212 pp., paper	Free	.15
**Bulletin No. 87. Commercial Minerals of California, with notes on their uses, distribution, properties, ores, field tests, and preparation for market, by W. O. Castello. 1920, 124 pp., paper	----	----
Bulletin No. 88. California Mineral Production for 1919, with County Maps, by Walter W. Bradley. 1920, 204 pp., paper	Free	.15
**Bulletin No. 89. Petroleum Resources of California, with Special Reference to Unproved Areas, by Lawrence Vander Leck. 1921, 12 figures, 6 photographs, 6 maps in pocket, 186 pp., cloth	----	----
Bulletin No. 90. California Mineral Production for 1920, with County Maps, by Walter W. Bradley. 1921, 218 pp., paper	Free	.15
Bulletin No. 91. Minerals of California, by Arthur S. Eakle. 1923, 328 pp., cloth	$1.00	.15
**Bulletin No. 92. Gold Placers of California, by Chas. S. Haley. 1923, 167 pp., 36 photographs and 7 plates (colored and line cuts, also geological map), cloth	----	----
Bulletin No. 93. California Mineral Production for 1922, by Walter W. Bradley. 1923. 188 pp., paper	Free	.15
**Bulletin No. 94. California Mineral Production for 1923, by Walter W. Bradley. 1924, 162 pp., paper	----	----
Bulletin No. 95. Geology and Ore Deposits of the Randsburg Quadrangle, by Carlton D. Hulin. 1925, 152 pp., 49 photographs, 13 line cuts, 1 colored geologic map, cloth	2.50	.15
**Bulletin No. 96. California Mineral Production for 1924, by Walter W. Bradley. 1925, 173 pp., paper	----	----
**Bulletin No. 97. California Mineral Production for 1925, by Walter W. Bradley. 1926, 172 pp., paper	----	----
Bulletin No. 98. American Mining Law, by A. H. Ricketts, 1931, 811 pp., flexible leather	3.00	.15
Bulletin No. 99. Clay Resources and Ceramic Industry of California, by Waldemar Fenn Dietrich. 1928, 383 pp., 70 photos, 12 line cuts including maps, cloth	1.50	.15
**Bulletin No. 100. California Mineral Production for 1926, by Walter W. Bradley. 1927, 174 pp., paper	----	----
**Bulletin No. 101. California Mineral Production for 1927, by Henry H. Symons. 1928, 311 pp., paper	----	----
Bulletin No. 102. California Mineral Production for 1928, by Henry H. Symons. 1929, 210 pp., paper	.25	.10
Bulletin No. 103. California Mineral Production for 1929, by Henry H. Symons, 1930. 231 pp., paper	.25	.10
Bulletin No. 104. Bibliography of the Geology and Mineral Resources of California, to the end of 1930, by Solon Shedd	2.00	.15
**Bulletin No. 105. Mineral Production in California for 1930 and Directory of Producers	----	----
Bulletin No. 106. Manner of Locating and Holding Mineral Claims in California (with forms)	.25	----
Bulletin No. 107. Mineral Production in California for 1931 and Directory of Producers	.25	.10

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† Not yet published.

PRELIMINARY REPORTS

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**Preliminary Report No. 1. Notes on Damage by Water in California Oil Fields, December, 1913. By R. P. McLaughlin, 4 pp.	----	----
**Preliminary Report No. 2. Notes on Damage by Water in California Oil Fields, March, 1914. By R. P. McLaughlin, 4 pp.	----	----
Preliminary Report No. 3. Manganese and Chromium, 1917. By E. S. Boalich. 32 pp.	Free	$0.05
Preliminary Report No. 4. Tungsten, Molybdenum and Vanadium. By E. S. Boalich and W. O. Castello, 1918. 34 pp. Paper	Free	.05
Preliminary Report No. 5. Antimony, Graphite, Nickel, Potash, Strontium and Tin. By E. S. Boalich and W. O. Castello, 1918. 44 pp. Paper	Free	.05
**Preliminary Report No. 6. A Review of Mining in California During 1919. By Fletcher Hamilton, 1920. 43 pp. Paper	----	----
**Preliminary Report No. 7. The Clay Industry in California. By E. S. Boalich, W. O. Castello, E. Huguenin, C. A. Logan, and W. B. Tucker, 1920. 102 pp. 24 illustrations. Paper	----	----
**Preliminary Report No. 8. A Review of Mining in California During 1921, with Notes on the Outlook for 1922. By Fletcher Hamilton, 1922. 68 pp. Paper	----	----

MISCELLANEOUS PUBLICATIONS

**First Annual Catalogue of the State Museum of California, being the collection made by the State Mining Bureau during the year ending April 16, 1881. 350 pp.	----	----
**Catalogue of books, maps, lithographs, photographs, etc., in the library of the State Mining Bureau at San Francisco, May 15, 1884. 19 pp.	----	----
**Catalogue of the State Museum of California, Volume II, being the collection made by the State Mining Bureau from April 16, 1881, to May 5, 1884. 220 pp.	----	----
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Samples (limited to three at one time) of any mineral found in the State may be sent to the Division of Mines for identification, and the same will be classified free of charge. No samples will be determined if received from points outside the State. It must be understood that no assays, or quantitative determinations will be made. Samples should be in lump form if possible, and marked plainly with name of sender on outside of package, etc. No samples will be received unless delivery charges are prepaid. A letter should accompany sample, giving locality where mineral was found and the nature of the information desired.

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PLATE III

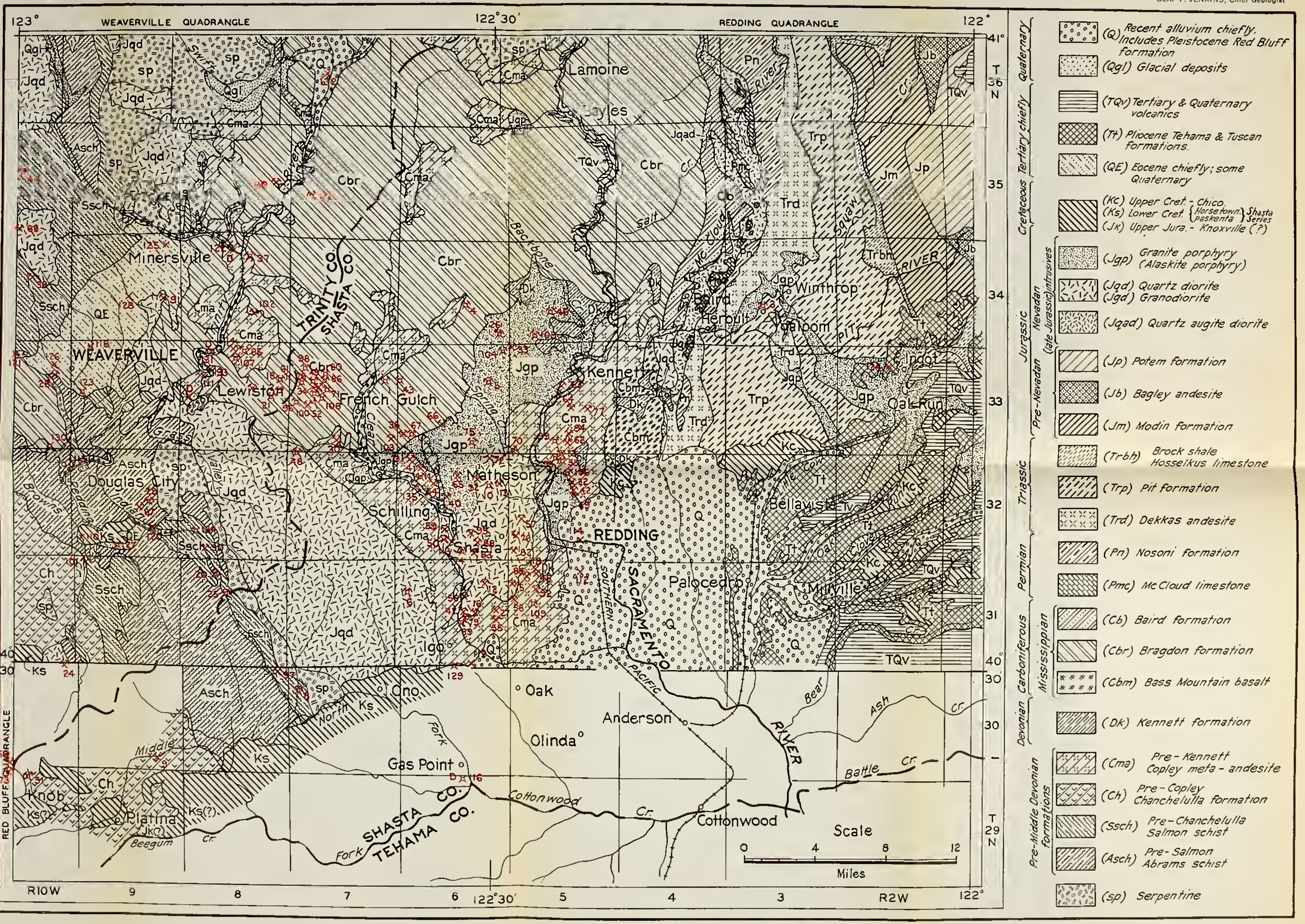
GEOLOGIC BRANCH
OLAF P. JENKINS, Chief Geologist

GOLD MINES
LOCATED AND DESCRIBED BY
CHAS. V. AVERILL
1933

- ⚒ *Quartz - Gold Mine*
- ⚒ *Quartz - Gold Prospect*
- ✕ *Placer - Gold Mine*
- × *Placer - Gold Prospect*
- ✕ *Gold Dredge*

No. 110 and higher are placers

(Numbers on map correspond to marginal numbers in text, where names of mines are arranged alphabetically, first the quartz mines, then the placer mines. Numbers of section, township, and range given in text, afford a means of quickly locating a mine number on this map.)



WEAVERVILLE QUADRANGLE
REDDING QUADRANGLE
RED BLUFF QUADRANGLE
123°
122°30′
122°
41°
40°
T 36 N
35
34
33
32
31
30
T 29 N
R10W
9
8
7
6
5
4
3
R2W
WEAVERVILLE
Minersville
Douglas City
Lewiston
French Gulch
Schilling
Matheson
Shasta
Kennett
Lamoine
Bayles
Baird
Heroult
Winthrop
Copper City
Ingot
Oak Run
Bellavista
REDDING
Palocedro
Millville
Igo
Ono
Oak
Olinda
Anderson
Gas Point
Cottonwood
Knob
Platina
TRINITY CO.
SHASTA CO.
TEHAMA CO.
SACRAMENTO RIVER
SOUTHERN PACIFIC
Scale
0
4
8
12
Miles
(Q) Recent alluvium chiefly. Includes Pleistocene Red Bluff formation
(Qgl) Glacial deposits
(TQv) Tertiary & Quaternary volcanics
(Tt) Pliocene Tehama & Tuscan formations.
(QE) Eocene chiefly; some Quaternary
(Kc) Upper Cret. - Chico.
(Ks) Lower Cret. {Horsetown, Paskenta} Shasta Series
(JK) Upper Jura. - Knoxville (?)
(Jgp) Granite porphyry (Alaskite porphyry)
(Jqd) Quartz diorite
(Jgd) Granodiorite
(Jqad) Quartz augite diorite
(Jp) Potem formation
(Jb) Bagley andesite
(Jm) Modin formation
(Trbh) Brock shale Hosselkus limestone
(Trp) Pit formation
(Trd) Dekkas andesite
(Pn) Nosoni formation
(Pmc) McCloud limestone
(Cb) Baird formation
(Cbr) Bragdon formation
(Cbm) Bass Mountain basalt
(Dk) Kennett formation
(Cma) Pre-Kennett Copley meta-andesite
(Ch) Pre-Copley Chanchelulla formation
(Ssch) Pre-Chanchelulla Salmon schist
(Asch) Pre-Salmon Abrams schist
(sp) Serpentine
Quaternary
Tertiary chiefly
Cretaceous
Jurassic
Nevadan (late Jurassic) intrusives
Pre-Nevadan
Triassic
Permian
Carboniferous
Mississippian
Devonian
Pre-Middle Devonian formations

GEOLOGIC MAP OF THE REDDING AND WEAVERVILLE QUADRANGLES AND THE NORTHWESTERN PART OF THE RED BLUFF QUADRANGLE, PREPARED BY N. E. A. HINDS

Redding quadrangle by J. S. Diller, was published in 1906; mapping revised in part by N. E. A. Hinds and R. Dana Russell in 1927-1930. Weaverville quadrangle mapped by N. E. A. Hinds in 1923-1931. Northwestern part of Red Bluff quadrangle mapped by N. E. A. Hinds and R. Dana Russell in 1929.

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